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NUTRITIONAL DISCOVERIES IN RELATION TO LIVESTOCK FEEDING PRACTICES *

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I was very much pleased to accept your kind invitation to attend the C.S.T.A. Convention this year where previously I was unable to do so on account of conflicting events at Madison. It is a privilege for me to meet at an occasion of this sort so many Canadian workers whose research publications are very well known and appreciated by us in the United States.

Energy

Any time we witness a mighty waterfall or thundering locomotive, or the enormous dimensions of a redwood tree, we are awed with a sense of the presence of enormous energy. Last summer our family motored through Rocky Mountain National Park, negotiating the highest automobile pass in the State of Colorado, Fall River Pass, which is considerably above timber line. I recall when we were still hundreds of feet below timber line that I marvelled at the fact that a single gallon of gasoline would lift our two-ton outfit way above that high rim of timber.

Let us think of the handful of rice that, we are told, keeps an oriental jinrikisha man travelling for hours. What power is locked up in those few ounces of food, mostly starch. And what a wonderful engine the human body ,or the animal body, is to transmute that locked-up energy into transportation.

Is it any wonder that the energy concept should make itself felt at an early date in the history of scientific feeding of animals. Thus Thaer in Germany in 1810 published a table of hay equivalents, where so many pounds of potatoes, cabbages, clover hay, or alfalfa hay equalled 100 pounds of meadow hay. His proposal was plainly dominated by an appreciation of the relative energy values of the various feeds. Nor have we ever been able to get away from energy as the most important factor in nutrition.

Protein

However, nutrition is a complex subject, and is becoming more complex right along. Even in the middle of the last century the protein need of animals and its demand upon the protein content of feed was known, resulting in the earliest feeding standard involving protein, the standard of Grouven in 1859. This was almost immediately improved upon by Wolff who had meanwhile found great differences in the digestibility of feeds, and who erected a feeding standard based upon the digestible crude protein, carbohydrates and fat required daily by different farm animals.

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These early feeding standards have been superseded at various times by other standards, especially those relating to dairy cows. None of the standards specify anything, however, than so much dry matter, digestible crude protein, carbohydrates, and fat. In view of the much expanded knowledge of nutrition at the present time, the faith of the early investigators in feeding standards speaks volumes for the foolproofness of ordinary rations for cattle, where in every case liberal amounts of hay or similar roughage entered into the ration. Thousands of children had meanwhile suffered from rickets, from the lack of one or the other vitamin, and the effects of other essentials in their diet. Thousands of sailors had sickened and had died from scurvy. Orientals even now are suffering from beri-beri and people in our own country from pellagra. But children or people cannot well be regimented into experimental lots and we have down to date paid the price of dietetic ignorance.

But laboratory animals have stepped into the breach. Some day we may erect a monument to the white rat as a martyr to the cause of nutrition. Not that everything can be found out from rats or similar experimental animals. I believe it was Mendel who said that long years of nutritional research had taught him that he could not argue from rats over onto babies. In the same way we are forced to the conclusion that if we want to be certain of satisfying the needs of this or that class of livestock, we need to do research work with those animals themselves. There is a tremendous species difference in the field of nutrition, as I shall bring out later.

We are deeply indebted, nevertheless, to those small animals that showed us how valuable this or that protein might be, how it might best be supplemented, also what specific minerals or vitamins might be necessary. In dairy cow feeding we often hear stressed the need of a variety of grains so that the protein of the ration as whole might be improved. If the poorest kind of roughage were fed, there might be more of a point to this contention. With good hay however, especially legume hay, there is a veritable constellation of proteins, even with a relatively simple mixture of home-grown grains, let alone the further addition of wheat bran and linseed meal. Hay is a wonderful safety feed in this respect, comparable to pasture. Why shouldn't pasture have complete proteins? Hasn't pasture nourished cattle on a thousand hills through all the ages? It seems as if old Nebuchadnezzar appreciated the adequacy of pasture in this or other respect, but may have had difficulty getting enough calories out of grass.

In 1915 Hart, McCollum and co-workers pointed out that alfalfa hay in cereal rations of pigs in the winter made for good growth and prevented or cured stiffness that used to be spoken of as rheumatism. Since then nutrition workers have had occasion to put a great deal of faith in leafy feeds, hay, greens, vegetables. After years of disappointment in raising fall pigs on grains, where no skim milk or other animal protein could be had, it was thought that protein from an animal scource was indispensable for successful growth of weanling pigs. It is a fine tribute to leafy hay that it serves so successfully as a substitute for skim-milk or tankage with respect to the *quality*, if not the quantity of proteins and minerals, and in addition vitamins that even the two animal feeds do not possess in any degree.

In 1925 while I was still at the Ohio Experiment Station we tried out a ration for weanling pigs in dry-lot which ration had in it no animal protein of any sort. The pigs were grown from a weight of 48 to 225 pounds. Ordinarily this would be a severe test, indeed. But we mixed into the ration carriers of proteins, minerals, and vitamins that previous nutritional work had established as superior combinations. The ration was made up of yellow corn, soybean meal, (nutty flavored and therefore palatable and efficient) linseed meal, and alfalfa meal. The ration also had included acid phosphate, ground limestone, and salt. This is a purely plant and mineral ration. The ten pigs in the lot gained 1.22 pound each on the average per day, requiring only 392 pounds of feed to produce 100 pounds live weight, the lowest feed requirement of the entire experiment. Another group of ten pigs that was fed corn, tankage, limestone and block salt, gained 1.16 pound daily per pig, and pigs on the rather efficient ration of corn, tankage, linseed meal, alfalfa meal, limestone and salt gained 1.20 pound a day. The vegetable and mineral ration was beaten only by the ration that contained skimmilk with tankage, corn, limestone, and salt, on which the pigs gained 1.33 pound per day.

Other experiments have borne out the results of this test, showing that very efficient rations can be compounded from grains and minerals for such a critical animal as the pig providing leafy hay is incorporated. The grains or grain products are not deficient so much in the quality of proteins as in the kind and amounts of minerals and vitamins. We have successfully grown pigs from weaning to market weight on grain protein entirely, and dairy calves from a few weeks to ten months of age, where the only roughage was ground wood shavings. To be sure, the necessary minerals and vitamins had to be supplied by some such carriers as ground limestone and cod-liver oil, but the grain protein proved adequate although such protein could have been rather efficiently supplemented by the protein of good hay.

The above results are not to argue for a strictly vegetarian diet whether for pigs or humans. The work is simply taking into account the relative scarcity of animal protein feeds having in mind the enormous hog population and, for that matter, the poultry population of the northern part of this continent.

You may be familiar with the way Dr. J. R. Slonaker of Stanford University exposed the rather uncertain creed of a confirmed vegetarian friend of his who based his vegetarianism solely on the fact that he ate no red meat but indulged freely in milk, butter, eggs, and fish. A most excellent diet can be arranged, of course, with these foods in them. Developing young animals of the carnivorous or omnivorous species on plant and mineral substances entirely, is a task requiring considerable information and ingenuity.

Minerals

Cereals and their products are almost uniformly lacking in lime and other minerals. I indicated before that ground limestone or other inorganic minerals were used in rations.

Some months ago the medical editor of a journal having a national circulation pointed out to his readers that minerals of inorganic nature could not be assimilated by the human or animal organism, that they were merely irritants. Salt he classed among these minerals that should be ruled out of the diet. In a letter I pointed out to him that on the basis of his statements

a whole army of nutrition workers would have to forget the results they had secured with feeding inorganic lime, phosphorus, table salt, iodine, and iron. I asked him his authority for such a statement, but I never heard from him, although I sent him the required self-addressed stamped envelope. *Of course,* inorganic minerals are utilized by the body. There are exceptions to this, and flowers of sulphur seems to be one of them. Even with sulphur it is a question but whether the intestinal flora may not to some extent be in a position to furnish the "Open Sesame!" on behalf of flowers of sulphur. But ground limestone when added to grain rations of pigs makes for wonderfully improved growth of bones and other tissues, and so do phosphates for dairy cattle.

I recall with pleasure the account Dr. Babcock gave me of the way the dairy cows of the University behaved when he and Dean Henry withheld salt from half of the herd.

By the way, a few days before I left Madison I told Dr. Babcock that I was going to this meeting in Nova Scotia. "Fine", said he, "give my regards to Nova Scotia!" He chuckled as he said it, realizing that he was giving me a large order. But it came spontaneously on his part and I feel like delivering the message.

Dr. Babcock mentioned that the cows without salt went along for months with no apparent ill effect although they evinced a strong craving for salt. The entire herd used to be driven across University Avenue to Camp Randall, and the salt-starved cows of the herd used to hurry ahead of the rest so as to be able to lick the dirt along the street car tracks where the employees had been using rock salt to thaw the ice off the tracks. At one time there had been a circus at Camp Randall and after it had moved the cows had eaten a sizable crater into the ground where the men at the refreshment stand had dumped the brine from the ice cream freezers. The real test, however, came at the time of calving when the calves came weak and dead, and when milk production was decidedly inhibited through months of salt starvation.

At the Iowa Experiment Station ewes and pigs from whom salt was withheld did so much less well than others properly salted that Dr. Evvard referred to salt as "white gold in the animal kingdom". He computed that in a pig feeding experiment one pound of salt had saved 582 pounds of feed.

Salt may not be such a problem in the Maritime part of Canada or the United States, but it certainly is not a mere luxury in the inland parts of the continent. There are exceptions, of course, in the alkali flats of the west. Every good thing, it seems, can be overdone.

We are aware of the fact that calcium and phosphorus constitute the major minerals in the composition of animals. About 85 per cent of the inorganic part of the bones is made up of calcium phosphate and 10 per cent calcium carbonate. I wish to emphasize the relationship of Ca and P in bones and in other substances. There are about 50 parts of elemental phosphorus for every 100 parts calcium, or about the same relationship as in tricalcium phosphate.

In the animal body as a whole, depending on the kind and condition, the phosphorus in terms of calcium varies from about .5 to .6. In milk it is about

.7, and in native pasture which is a mixture of grasses and legumes, we will have the P value in most cases fall within the extreme limits of the range.

Here are the animal body and naturally occurring food stuffs where there are approximately 3 parts of elemental calcium for every 2 parts of elemental phosphorus by weight. McCollum and Simmonds stated that their optimum amount of calcium in a ration for rats was .64 per cent and phosphorus .41 per cent. This is a ratio of 1 to .64. In repeated experiments with pigs at the Ohio Experiment Station where yellow corn, soybean meal and salt were the basal ration, the proximate ratio of 1Ca to .66 P proved the best. In this case the antirachitic factor in the ration was low. If cod-liver oil or similar vitamin-D potent feed was given, or if the animals were exposed to sunlight or ultraviolet light, all rules of Ca and P ratio seemed called off. The relationship could teeter one way or the other and still result in good growth and bone structure. But where omnivora so far studied were put on a diet really deficient with respect to vitamin D or its equivalent in ultraviolet light, it was more important that the ratio of Ca to P was proper, coming near the ratio of 3 to 2 indicated, than that the absolute amount of the two elements be at a certain level. The ratio was more important than the amount of the two. In general where a grain ration is fed balanced with proteins of grain or seed by-products, 1½ per cent of ground limestone in the ration will give this favorable proportion of Ca to P.

In poultry we have a different situation where due to the growth of feathers and the need of lime for egg shells there needs to be a larger proportion of calcium to phosphorus. Bethke and co-workers at the Ohio Station found that growing chicks needed to have from 3 to 4 parts of calcium for every 1 part of phosphorus in their rations.

At the University of Wisconsin birds could be given ratios of Ca to P widely varying from any so far mentioned and still produce good results providing they had plenty of sunlight. In the absence of optimum sunlight it was found that 2 calcium to 1 phosphorus was the optimum proportion.

Dairy cows do not follow any fixed rule in this respect. An abundance of vitamin D in their ration, as carried by hay or other roughage, renders a rigid proportion of Ca to P unnecessary. Cows at the Wisconsin Station have continued to thrive and give milk on rations of alfalfa hay or clover hay, with ratios of 1 Ca to .17 P. On the other hand they have had to subsist on rations of timothy hay with perhaps a protein-balancing grain mixture, yielding a proportion in the reverse direction of the above, and with surprising nutritional success considering the deviation from the relationship of Ca and P in a natural diet.

Depending on whether alfalfa or timothy hay are used with a grain mixture, therefore, bonemeal or limestone would be called for in order to secure the supposedly correct proportion of 3 parts Ca to 2 parts P. The P of bonemeal would balance the Ca of the alfalfa hay ration, and the Ca of limestone the relatively high P of timothy hay and grain mixture. This has not been put to any critical test so far, and would require a ration for dairy cattle that would be low in vitamin D, where perhaps ground wood shavings or similar material low in vitamin D serves the place of roughage.

With further respect to the availability of inorganic minerals to the animal organism, iron is another instance where a mineral in an inorganic state is assimilated from the digestive tract. Two years ago Professor E. B. Hart announced the discovery of the copper-iron combination as a preventive and a cure for nutritional anemia in rats and rabbits, as brought about by an exclusive milk diet. Difficulty had been experienced in the past in having iron serve as a curative agent in every case of anemia, although iron was plainly lacking for hemoglobin building. Liver and liver extract would cure anemia and so would lettuce. Even ashed liver and lettuce cured this form of anemia, showing the curative agent or agents to be of an inorganic nature. A peculiar bluish color of this ash furnished an inkling to the investigators that copper might be involved. When minute quantities of pure copper sulfate were added to the common dosage of inorganic iron (ferric sulfate) the hemoglobin of anemic rats immediately increased, showing that the presence of copper enabled the iron to be used for hemoglobin building.

The following winter we tried out iron in various amounts in rations of brood sows to see whether we might influence the store of iron in new-born pigs the following spring. We found that it was impossible to affect the amount of iron in new-born pigs or to prevent anemia in suckling pigs, by feeding iron and copper to the sow. It seemed that the mammary gland was an effective barrier to this element. Milk is notoriously low in iron, thus accounting for anemia on an exclusive milk diet such as these pigs were subjected to. These pigs suffered from "thumps" which appears to be one evidence of anemia. Copper and iron had to be fed to the pigs directly rather than through the sow in order to enable them to recover from anemia. McGowan and Crichton at the Rowett Research Institute in their paper on "Iron Deficiency in Pigs" gave a lead in this respect, but they were unable to determine whether the young pigs from sows receiving ferric oxide were benefited by iron received through the milk of the sows or by obtaining iron from the refuse. It should be noted that most impure iron salts have enough copper in them to serve in hemoglobin synthesis. Copper serves in the nature of a catalytic agent in the assimilation of iron. Copper itself is not found in hemoglobin.

By feeding a teaspoonful daily of a solution of 3.6 ounces of ferric sulfate dissolved in 5 quarts of water we were able to bring the hemoglobin picture of anemic pigs back to normal. Or, in a more practical way, by allowing a pig to nose over the feed of the sow, where this was rich in iron, anemia could be prevented. Running out on grass and having a chance to eat this and some soil along with the feed, proved especially effective. It is the early spring pig in our northern regions subsisting almost entirely on sow's milk that is handicapped from the standpoint of "thumps" and anemia, as brought on by iron-deficient milk.

Vitamin A.

Small laboratory animals, primarily rats, have enabled the discovery of various accessory feed substances, not falling within the class of what we think of as the major nutrients. This vitamin work during the past 15 years has had phenomenal results. In the naming of a long list of vitamins we may in time exhaust the alphabet and have to start a different nomenclature.

It was only through synthesized diets, using highly purified and expensive nutrients, carbohydrates and the like, that the existence or need of these vitamins could be found out. Ordinary rat rations no more than ordinary dairy cow or pig rations could possibly have led to such findings.

But having in mind rations that may only too frequently be fed and that are suspected of being deficient in one or more respects, what are the vitamin deficiencies in livestock that we may need to watch for? It is the lack of vitamins A and D, the two that are contained in such abundance in cod-liver oil and that in other food stuffs are widely distributed in nature. These are about the only ones that concern the stockman and even then, as hinted in the wide distribution, many stockmen need never know they exist. Why? Because ruminants and horses are so well protected through the consumption of grass or hay that are rich in several vitamins.

But there may be vitamin deficiencies in rations even of cows and horses, depending on the particular region with respect to climate and crops on which they may be obliged to subsist. One of our graduate students from Oregon a year ago expressed a conviction that the so-called "walking disease" experienced among range horses in eastern Oregon, usually in the spring of the year, was due to a vitamin A deficiency. The roughage they subsist on is badly weathered and bound to be low in the organic accessory food substances known to be necessary for other farm animals.

In 1907 Hart, McCollum, Steenbock, and Humphrey started a feeding test with dairy cows that were fed rations balanced from restricted sources. One group was fed a ration balanced from the oat plant, oat grain, and oat straw. A second one was similarly fed on wheat and a third one yellow corn. Ordinary salt was fed in every case. In the wheat and corn groups, wheat gluten and corn gluten were fed respectively, so as to balance the ration from the protein standpoint. The corn lot did fairly well with respect to milk production and reproduction. The oat-fed cows did not do so well, and those fed wheat, worst of all. The cows became shaggy coated, listless, dragging their hind feet. All of the calves came prematurely, some of them dead at birth, others dying soon afterwards. When yellow corn replaced the wheat, there was an improvement in the condition of the animals. At that time nothing was known of vitamins. It was supposed that there was a toxic principle in wheat that accounted for the disastrous results. In 1923, or 16 years later, this experiment was repeated in part and with this modification that bonemeal and cod-liver oil were fed in addition to the wheat straw, wheat gluten, ground wheat, and salt. The record of the cows on this ration was quite in contrast with the previous evident hardship on the unsupplemented wheat ration. They now produced strong, healthy calves. While lime was undoubtedly needed as furnished by the bonemeal, and possibly some phosphorus was needed ,there is evidence, judging from other work and particularly the fact that the unsupplemented yellow corn seemed quite adequate, that vitamin A was the most essential single ingredient furnished by the bonemeal-cod-liver oil addition which made the wheat ration relatively efficient.

We have lately had fairly good growth on a deficient ration where cod-liver oil was added, but not where irradiated yeast was added. The ration consisted of yellow corn, corn gluten meal, linseed meal, wheat middlings,

calcium carbonate, salt, and ground wood shavings. It seems that not enough vitamin A was furnished by the yellow corn which made up one-half of the concentrates. We are now repeating the experiment where we are adding in one case normal cod-liver oil, in another aerated cod-liver oil, in still another, sunlight. Two other lots receive vitamin A, one of them with sunlight and the other without. While sunlight in other experiments has not proved effective or beneficial for calves, they were fed more or less normal rations rather than such as would put to a more critical test their vitamin D requirement. As a source of vitamin A, we are feeding canned tomatoes. This is done on the belief which is fairly well substantiated that vitamins B and C in the ration are no factors in the nutrition of calves. Canned tomatoes are recognized as very potent in vitamins A, B, and C, but low in D. We hope in this instance to secure further clues as to the vitamin A and D requirements of dairy cattle, which vitamin needs have not, mainly because of the hay or roughage feeding of cattle, been as clearly established as in the case of pigs and poultry. It is well known, of course, that cows respond to a generous allowance of vitamin A, as found in pasture, by shunting more of this vitamin into summer milk.

Pigs have given unmistakable signs of needing vitamin A in the way they respond to yellow versus white corn in dry-lot, as was first demonstrated in 1920 at Wisconsin after Dr. Steenbock had discovered that yellow corn was rich in vitamin A which, however, was lacking in white corn. Later at the Ohio Experiment Station we found that tankage, the popular protein feed for pigs in the corn belt, was lacking in A. Hughes of Kansas in feeding white corn and tankage to pigs in dry-lot, and doing so for many months, some seven or eight being required, was able to demonstrate that this vitamin A deficient ration led to nerve degeneration, blindness, and staggers, which could be prevented by feeding butterfat or alfalfa meal. In our rickets work at Ohio we would at times in our vitamin-A deficient rations, be baffled by indications of incoördination of leg movement of the pigs and by stiffness so that we remarked about it in our discussion of the experiments, saying that it was difficult to escape the conviction that a lack of vitamin A as well as D was involved in the symptoms observed. Most of our experiments ceased at the end of five months so that we did not get as clear a picture of vitamin-A starvation in pigs as did Hughes, although we could demonstrate satisfactorily the effect of a D deficiency on the growth of bones and the animal as a whole.

Vitamin D.

It is interesting to contemplate the responses of animals of different species to vitamin D or its equivalent in sunlight or ultraviolet light. Chickens have a very keen need of vitamin D or direct sunlight, hogs less so but still pronounced, and cattle least of all. Probably the most striking thing in nutrition is an exhibit which Professor Hart has in his office, showing that sunlight not only vastly increased the egg production of irradiated birds, but also the hatchability of their eggs. This is a phenomenal showing on the part of irradiation, considering the apathy of cows in this respect.

The only parallel to this situation that I can think of is that of the response of different species of animals to scabbed barley, infected with *Gib-*

berella Saubinetii. This diseased barley was extremely nauseating to pigs and dogs, and incidentally humans, and caused horses to refuse to eat it. But dairy cattle, beef cattle, sheep and chickens relished it, not differentiating in the least, as far as we could observe between scabbed and normal barley of the same kinds that had been fed to the susceptible species. It seems as if animals with compound stomachs, not excepting the chickens with their crops, can neutralize the toxin or else do not have a vomiting center of their nervous system to disturb them. For in proof that no mere stomach irritation was involved, we could by-path the stomach of pigs by intravenous injections of the active principle and still secure violent vomitting.

While not as sensitive to vitamin D or sunlight as chickens, pigs nevertheless are remarkably responsive to the antirachitic principle as shown among other stations, and with respect to ultraviolet light, at Wisconsin, Ohio, Cornell, and Iowa, and with respect to cod-liver oil at innumerable places, aside from experiment stations. We are told that it is a common thing in Denmark to have a barrel of cod-liver oil for feeding purposes standing in one end of a hog barn.

The feeding of cod-liver oil has not been proved economical as yet in and around the corn belt. More practicable as a growth promoter for pigs under trying climatic conditions, as in the winter, is the mixture of tankage, linseed meal, and ground alfalfa hay as a combined protein, mineral and vitamin supplement to be fed with corn or other grain. This mixture, or modifications of this mixture, are rather widely used by swine growers, and with excellent results.

It is the use of first class roughages like alfalfa, clover hay, and pasture or forage crops that we are inevitably led back to as the feeds that make for economy and safety in the nutrition of farm animals. More than anything else, the recently acquired knowledge of nutrition is showing us that the old way, perhaps the very old way, of depending on what Dame Nature has provided for our livestock is after all the thing to tie to. We must remind ourselves once more that thousands of generations of cattle and their kind have thrived on grasses though the ages and that this is a convincing argument for the presence in grass or its equivalent of all of the nutrients now singled out, one after another, as indispensable.

THE MINERAL FEED PROBLEM WITH DAIRY CATTLE AND SWINE *

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At a recent meeting of the Central Retail Feed Association at Milwaukee, Wisconsin, the writer was asked the following question: "Is mineral feed worth the price?" The answer was, "Yes and no." The reason the answer had to be of this nature was that under certain conditions, as can be demonstrated experimentally, mineral feeds used with rations may be worth all that is asked for them. Such conditions or such rations are relatively rare, however, in actual practice. With the knowledge of feeding that we now possess, where in swine rations we may feed good animal proteins such as tankage, fishmeal, or skimmilk, with a further addition of alfalfa meal or similar ground legume hay in case the pigs happen to be in dry-lot, there is little or no need for additional minerals other than salt, and in the Great Lakes region and the northwest, possibly iodine.

Proof for this statement is furnished by an extended series of experiments at the University of Wisconsin involving 260 gilts or brood sows (see table 1), where the addition of minerals or mineral mixtures of various sorts proved of no benefit when fed with good rations. These rations in the summer when the pigs were on grass consisted of a grain mixture, in every case containing tankage and in the winter both alfalfa meal and tankage.

Similar results were secured more recently at the Oklahoma Experiment Station where with good rations of the sort mentioned, additional minerals in the ration proved superfluous. In fact, a review of the literature of mineral feeding of pigs, with few exceptions, shows that with rations compounded according to the latest information on scientific feeding and, therefore, including efficient proteins and adequate vitamins, using practical carriers of such nutrients, additional minerals other than salt and possibly iodine are unnecessary.

In the case of dairy cows the same principle applies. If their ration includes good legume or mixed legume and grass hay and a grain mixture which has in it a fair amount of wheat bran, linseed meal, cottonseed meal or similar high-phosphorus protein feeds, there is little danger from a lack of lime and phosphorus which are the minerals most apt to be deficient in amount.

Very convincing arguments in this respect are long-continued mineral feeding trials with dairy cows at several experiment stations where no significant benefits were secured from the addition of minerals whether steamed bonemeal, dicalcium phosphate, or a mineral mixture. Noteworthy in this respect are the experiments at Massachusetts, Ohio, Michigan, and Wisconsin.

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TABLE 1.—*Do pigs need additional minerals with good rations?*

Ten gilts per lot were fed from weaning to farrowing. Basal ration: yellow corn, oats, middlings, tankage, linseed meal, on pasture. In winter, alfalfa hay in rack.

Minerals Fed	Number of Tests	Av. Daily Gain	Feed per 100 lbs. Gain			Av. No. of Pigs per Litter	Av. Wt. per Pig	Rating of Offspring		
			Hay Alfalfa	Minerals	Total Conc. not inc. Hay or Minerals			% of Pigs above Medium	% of Medium Pigs	% of Weak and Dead Pigs
No minerals	5	1.08	16.3		520	8.5	2.7	49.99	26.84	23.17
Bone meal	5	1.01	18.2	10.7	542	7.7	2.6	54.54	19.65	25.82
No minerals	2	1.00	22.5		510	6.8	2.7	51.58	32.65	15.78
Bonemeal	2	.94	24.4	10.5	538	6.4	2.6	58.98	28.00	13.02
Limestone	2	.95	23.6	10.4	531	5.9	2.8	57.44	25.12	17.44
No tankage, No minerals	2	.94	24.4		556	7.1	2.4	46.45	23.39	30.15
No minerals	2	1.15	9.6		476	9.6	2.8	48.18	19.23	32.63
Mineral Mixture A—(Complex)	2	1.10	11.2	9.8	492	10.2	2.5	43.74	20.31	35.98
No minerals	1	.98	38.9		522	6.3	2.7	61.23	32.61	6.16
Floats	1	.91	31.1	10.9	555	4.9	2.5	53.20	31.41	15.39
No minerals	1	1.17	8.8		573	10.1	2.8	62.88	16.50	20.65
Mineral Mixture B—(Simple)	1	1.14	12.9	11.3	572	9.4	2.9	65.85	14.98	19.13

TABLE 2.—*Most common mineral deficiency diseases in livestock.*

Particular deficiency	Class of livestock affected	Symptoms and ailments	Some substances rich in the essential factors
Salt	All livestock	Digestive disturbance, ultimate breakdown.	Salt in various forms (flake, block, rock), also iodized salt, alfalfa hay.
Lime	Hogs (fed grain mixtures in dry-lot)	Poor growth, rickets, stiffness, broken bones, posterior paralysis.	Milk, skimmilk or buttermilk, tankage, fishmeal, good pasture or hay (legume), limestone, marl, bonemeal, fertilizer phosphates, various calcium salts.
	Dairy Cattle Beef cattle Horses Sheep	Depressed growth, or production, (Complete breakdown rare.)	
Phosphorus	Hogs Dairy Cattle Beef Cattle Sheep	Not common. Depraved appetite, "bone chewers", pica, bone fractures and lesions, reduced production, emaciation, reproductive disturbance, young animals unthrifty, knock-kneed, bow legged, "pigeon breasted".	Wheat bran, wheat middlings, cottonseed meal, linseed meal, rice polish, bonemeal, fertilizer phosphates.
	Horses	Not common.	
Iodine	All livestock	Goiter or "big neck", hairless pigs, suboptimal growth.	Potassium iodide, kelp. Crops grown in most of U.S. and Canada except Great Lakes region and parts of northwest.
Iron	Hogs	Anemia in suckling pigs	Tankage, fishmeal, linseed meal, legume hay, pasture (except in isolated regions), grains are fairly rich in iron, copperas, iron oxide
	Dairy Cattle Beef Cattle Horses Sheep	Not common Not common Not common	
Copper	All livestock	Not common	In most feeds, copper sulphate, impure iron salts.

TABLE 3.—*Most common vitamin deficiency diseases in livestock*

Particular deficiency	Class of livestock	Symptoms and ailments	Some substances rich in the essential factors.
Vitamin A	Hogs (fed grain mixtures in dry-lot).	Pneumonia, degenerated nerve tissue, incoordinated gait, occasional blindness, poor growth.	Cod-liver oil, milk (especially summer milk), pasture, good hay, yellow corn.
	Dairy cattle	Not common.	
	Beef cattle	Not common.	
	Horses	Not common.	
	Sheep	Not common.	
Vitamin D.	Hogs (fed grain mixtures in dry-lot).	Rickets, stiffness, broken bones, posterior paralysis, (not common where lime is provided).	Cod-liver oil, summer milk, pasture, good hay (cured in sunlight), irradiated yeast and other foods, direct sunlight.
	Dairy cattle Beef cattle Horses Sheep	Rare except as lack of vitamin D is linked with a lime and phosphorus deficiency.	

These experiments were carried on with herds of cows averaging good producers but not necessarily including very high producers. But neither were the basal rations of the best as, for instance, the work at Massachusetts which utilized only a fair grade of mixed grass hay.

There are always exceptions with respect to the question of the need of mineral feeds. There are great differences as to individuality of animals as well as variations in feeds, depending on where they may be grown or under what climatic conditions, so that in many instances it may be reassuring to a dairyman or swine grower to let his animals have access to minerals in case they should have a craving for them.

With these exceptions in mind, tables 2 and 3 are presented showing what mineral deficiencies or combined mineral and vitamin deficiencies may be incurred in livestock even though in most cases fairly common and practical rations may be fed.

SMUT OF WILD OATS *

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The following notes on smut of wild oats may be of interest in view of the prevalence of this troublesome weed. Previous to 1928, as far as the writer is aware, smut *Ustilago levis* (Kellerm. & Swingle) Magn. or *U. avenae* (Pers.) Jens. on wild oats *Avena fatua* L. had not been reported as occurring in Western Canada. A collection of *U. levis* on wild oats was made near Frobisher, Sask. in July 1928. In 1929, Mr. I. L. Conners and Mr. B. J. Sallans collected *U. levis* on wild oats at Alameda, Sask.

Some inoculation tests had been conducted in the greenhouse at Saskatoon in the winter of 1926-27. Wild oats collected at Indian Head were heavily inoculated with a mixture of smut spores from common oats. In a short time one plant emerged and showed finally several heads infected with *U. levis*. Several other plants emerged after the pots had been set outside and frozen but none of these showed smut.

Further greenhouse inoculation tests by Mr. G. A. Scott, showed that the smut on wild oats could be transferred to Victory common oats and smut on Victory common oats to the wild oats. It was rather a simple matter to inoculate wild oats and in one test they showed an infection of 75 per cent. The smut in each case was *U. levis*.

Mr. B. J. Sallans and Mr. W. G. Sallans conducted some inoculation tests under field conditions at Indian Head in 1929. The seed used consisted of a sample of wild oats from the 1926 crop, a sample each of black and white wild oats from the 1928 crop and Banner oats to serve as check. These were divided into two lots, one being inoculated with covered smut and one with loose smut. The inoculation was done by thoroughly dusting the seed with the smut spores. They were sown on May 18th in rod rows. The emergence in the case of the 1928 wild oats was poor. The results are given in the following table:—

Seed	Inoculated with Covered Smut.		Inoculated with Loose Smut	
	Total No. of Heads	Heads Infected %	Total No. of Heads	Heads Infected %
Wild Oats 1926	466	51.28	522	11.30
White wild Oats 1928	189	20.63	199	1.00
Black wild Oats 1928	171	23.39	108	4.63
Banner Oats	402	22.13	413	10.89

Mr. G. Godel of the Provincial Department of Agriculture while carrying on weed investigations collected some very good speciments of *U. levis* on

*Contribution from Division of Botany, Dominion Experimental Farms.
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A. fatua. These oats had been selected from a granary and grown in nursery rows at Drinkwater, Sask., in 1929.

A sample of oats containing many wild oats and badly contaminated with smut was brought into the laboratory by Mr. W. B. Fells. The oats had been grown on his farm near Dundurn, Sask. Some of the common and wild oats were selected from the sample and grown in the greenhouse. Upon heading it was found that six out of twelve plants of the common oats were infected with *U. levis* and out of twelve wild oats nine were infected with *U. levis.*

That smut on wild oats has not been found more frequently seems strange. It may be increasing as the wild oats are becoming more common. Smut on *Avena fatua* is not listed by Bisby, Buller and Dearness (*2*), but *Ustilago levis* (Kellerman & Swingle) Magn. on *Avena fatua.* var. *glabrata* Peterm. is recorded by Seymour (*10*). *Ustilago avenae* (Pers) Jens. on *A. fatua* is recorded from Australia by McAlpine (*4*) from Russia by Vavilov (*11*) and according to a report of survey for Plant Diseases in East China as being common in the region of Nanking (*1*). *Avena fatua* is reported as susceptible to both *U. levis* and *U. avenae* by Reed (*5, 6, 8*) and by Reed, Griffiths and Briggs (*7*). Inoculations of *A. fatua* with *U. avenae* were reported recently by Moldenhauer (*3*) and Rosenstiel (*9*).

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LIVESTOCK CYCLES IN CANADA *

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It is generally recognized amongst professional agriculturalists that we have fairly definite periods of over- and under-production in agriculture. In the history of agriculture we can trace long periods when the prices of most agricultural products have been high relative to non-agricultural prices, followed by periods when agricultural prices were low relative to non-agricultural prices. These periods have generally been due to the opening up of new fertile lands on a vast scale, or to periods of inflation and deflation. Operating at the same time as these long periods we have shorter periods of over-and under-production, or fairly regularly recurring cycles of production. With crops as a rule, owing to the influence of the weather, these latter periods are apt to be very irregular. However, even with crops in many cases the influence of price can be seen in increased acreages followed by a consequent lowering of crop prices a few years later. Warren (*1*) has shown that the periods of over- and under-production of apples last from 20 to 25 years. The most definite cycles of over-and under-production occur however, in the cases of livestock.

Probably the most attention to livestock cycles has been centered on hogs. This is probably due to the fact that the cycle is so short that a man in his own lifetime can notice many of these regularly recurring waves of hog prices.

In 1876 Benner (*2*) first drew attention to the recurring short cycles in hog prices. Warren (*3*) showed that the hog cycle usually lasts from 4 to 6 years. Wallace (*4*) was probably the first one to analyse the hog cycle statistically with multiple correlation studies. Wentworth and Ellinger (*5*), Wright (*6*) and Sarle (*7*) pursued the mathematical analysis of the hog cycle further. Haas and Ezekiel (*8*) made a very complete analysis of the factors affecting hog prices by multiple correlation analysis. Warren and Pearson (*9*) have shown very clearly that the horse cycle has a duration of about 25 years, the beef cattle cycle about 14 to 15 years, and the hog cycle 4 to 5 years.

In view of the foregoing work the present article is in no way intended to disclose anything new regarding livestock cycles but merely to present the available data on livestock prices in Canada in a series of statistical charts, as an aid to making intelligent forecasts as to the trend of future livestock prices, and as a basis for further work in analysing price cycles of the various livestock products in Canada.

As no doubt some readers will only be interested in the interpretation of the results, it is deemed wise to give the results first. For those who are interested in the methods and price series used, the latter part of the article has been added.

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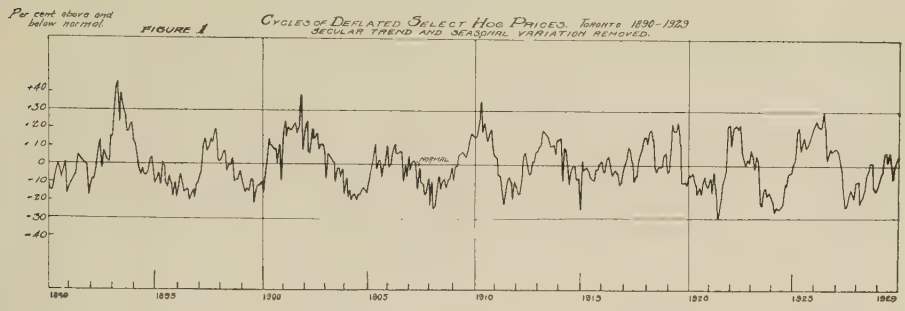

Figure 1.

The cycles of high prices in the past have occurred at intervals of about 4 to 5 years. A major cycle appears to be followed by a minor cycle. The cycle has now been rising for 3 years. The peak will apparently be reached this year or early in 1931.

The Hog Cycle

During the period studied the hog cycle in Canada (figure 1) has had nine distinct peaks. The complete cycle appears to be approximately 4 to 4½ years from peak to peak. In the 40 year period a large cycle appears to be followed by a small cycle thus making a major cycle every 9 years. With the exception of an odd month or two the fluctuations of the recurring deflated hog price cycles apparently vary within 25 per cent above or below the long time trend. The reason for these price waves or cycles is almost too obvious to need any comment. Everybody knows the tendency for the majority of farmers to expand their breeding at a time of comparatively high prices causing increased hog runs in the near future. The fact that our hog prices in Canada are governed to some extent by European and

Table 1.—*Livestock on farms on January 1st as reported by the United States Department of Agriculture and livestock on farms June 1st as reported by the Dominion Bureau of Statistics.*
1910 - 1930.

Year	Hogs (000 omitted)		Cattle (000 omitted)		Sheep (000 omitted)	
	U. S.	Canada	U. S.	Canada	U. S.	Canada
1910	58,000	2,750	69,000	7,100	52,000	2,600
1911	66,000	3,630	61,000	6,500	54,000	2,170
1912	65,000	3,480	58,000	6,400	52,000	2,080
1913	61,000	3,450	57,000	6,700	51,000	2,130
1914	59,000	3,430	57,000	6,000	50,000	2,060
1915	65,000	3,110	58,000	6,000	50,000	2,040
1916	68,000	3,480	62,000	6,600	49,000	2,020
1917	68,000	3,620	65,000	7,900	48,000	2,370
1918	71,000	4,290	67,000	10,000	49,000	3,050
1919	75,000	4,040	69,000	10,100	49,000	3,420
1920	59,000	3,520	69,000	9,600	39,000	3,720
1921	56,000	3,900	67,000	10,200	37,000	3,680
1922	58,000	3,920	67,000	9,700	36,000	3,260
1923	68,000	4,410	66,000	9,200	37,000	2,760
1924	66,000	5,070	65,000	9,500	38,000	2,680
1925	55,600	4,430	62,000	9,300	38,000	2,760
1926	52,100	4,360	59,000	9,200	40,000	3,140
1927	54,800	4,690	57,000	9,200	42,000	3,260
1928	60,600	4,500	56,000	8,800	45,000	3,420
1929	56,900	4,380	56,000	8,900	47,000	3,730
1930	52,600		58,000		49,000	

American hog production lends force to the argument that the expansion and contraction of hog breeding the world over is in very close correlation.

By referring to table 1 it will be noticed that in general the numbers of hogs in Canada and the United States decrease or increase at about the same time. The few years when these increases or decreases do not coincide might be due to the different time of the year in which the statistics are collected.

Hog prices have now been rising at Toronto for 3 years and it is 4 years since the last high point of the cycle was reached. At the time of writing the deflated price is about 20 per cent above normal and if the cycle is to behave as in the past we cannot expect hog prices to rise for much more than 6 months before the decline in the cycle occurs. Hog slaughterings both here and in the United States are continuing to decrease each month over the corresponding month of the previous year. However, since May 1929 the percentage of sows in the number of all hogs slaughtered in the United States has been smaller than for the corresponding months of the previous year. (10) This indicates a tendency to increase the breeding herds of the United States with a consequent future lowering of prices.

That lower prices may be expected for hogs in 1931 and 1932 is also the opinion of the United States Department of Agricultural Economics, and more particularly if the corn-hog ratio continues as favourable for hog producers as it is at the present. (11).

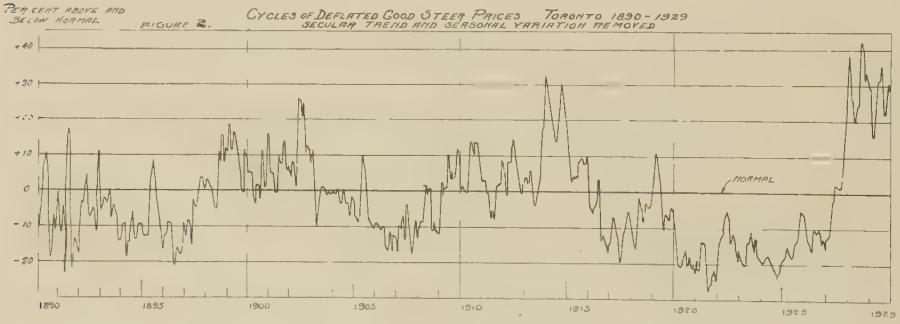

Figure 2.

From 1890 to 1928 there were 3 periods of high prices approximately 14 years apart. The indications are that increasing cattle numbers are causing the cycle to recede.

The Beef Cattle Cycle

The beef cattle cycle in Canada during the 40 years studied shows three periods of high prices (figure 2). The centre of the first high period was about the years 1900 and 1901. The next high point was 1914 and the last apparently 1928. Thus the 3 peaks of the cycle have occurred 14 years apart. This agrees with the findings of Warren and Pearson who state that the major centres of high prices are approximately 14 to 15 years apart. Actually the price of beef cattle was considerably higher in 1919 than in 1914; but relative to the general price level the peak was reached in 1914.

Figure 2 brings out distinctly why in the post war deflation period, from about the middle of 1920 to 1924, the beef industry was harder hit than most

other types of agriculture. After 1914 a natural decline in the deflated price cycle for beef had set in due to increasing numbers of cattle. However, the rapid jump in the general price level from 1917 to 1920 temporarily tended to derange the cycle by forcing the price up in spite of increasing numbers of cattle. This in turn tended to stimulate cattle breeding as did the prices in 1914. By referring to table 1 it will be noticed that in Canada the total number of cattle increased from 6,000,000 in 1914 to 10,000,000 in 1919. An increase in cattle numbers was to be expected after the comparatively good prices in 1914 but the added stimulus of the rapid climb in the price level, as mentioned previously, tended to emphasize the increase in cattle population. With increasintg cattle numbers and the inability of the cattle breeder to adjust his production to the rapidly changing prices relationship the stage was all set for the severe decline in beef prices both in Canada and the United States. This decline set in when deflation started in July 1920.

The cattle population of the United States declined from 69,000,000 in 1920 to 56,000,000 in 1929. The numbers in Canada declined from 10,200,000 in 1921 to 8,800,000 in 1928. This downward trend in cattle numbers has been reflected in the rapid rise in prices since 1924. However, the tide has turned and in June 1929 Canada for the first time in 7 years shows an increase in numbers. On January 1st, 1930 the United States had an increase of 2,000,000 over the previous year. This is the first increase since 1920.

At the time of writing the deflated price with the seasonal variation removed is about 20 per cent above normal. We can expect the increasing cattle numbers both here and in the United States to cause a downward trend in prices for another 5 years at least.

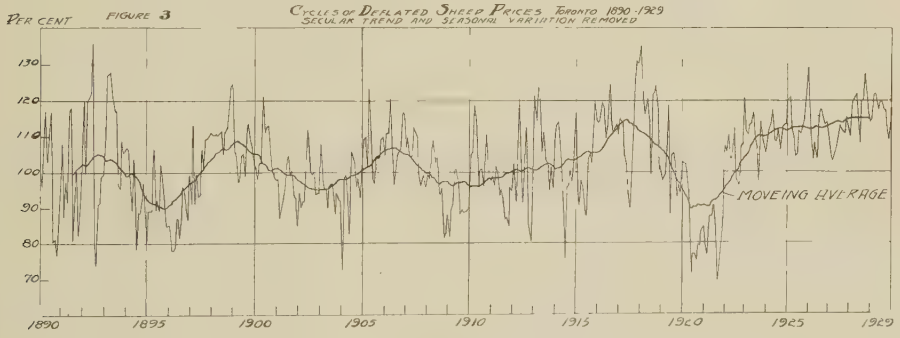

Figure 3.

The sheep cycle does not appear to be as regular as the other livestock cycles, probably due to the influence of wool prices which in turn are partially affected by business conditions. Sheep prices have been comparatively good for 5 years, but prices started down in 1929.

The Sheep Cycle

The sheep cycle does not appear to be as regular as in the case of beef cattle and hogs. During the 40 years the periods of high prices have occurred 5, 6, 7, 8 and 10 years apart (figure 3). The fluctuations from month to month in spite of the removal of season variation are more violent than for the other types of livestock. To bring out these cyclical fluctuations a 37

months moving average centered on the middle month has been constructed. (It will be noticed that this moving average does not show a small cycle that occurred about 1910).

The fluctuations of the cycles appear to vary from 80 to 110 per cent of the normal deflated price. The decline in price of sheep that started in 1918 and lasted until 1922 put the sheep industry temporarily in as bad shape as the beef industry. The sheep population of the United States declined 10,000,000 during the year 1919 (table 1). The decline in wool prices in 1920 along with other commodities was followed by a still more drastic decline in wool prices in 1921. The United States farm price for wool in that year was 16.5 cents per pound compared with a five year pre-war average of 17.7 cents per pound (12), but in 1921 the general price level index was 150. (1910-14 =100). Wool, therefore, had a purchasing power in 1921 of only 62 (purchasing power of wool 1910-14 = 100).

In the post-war deflation of 1921 wool prices were depressed more than any other agricultural commodity price.

The number of sheep in the United States continued to decline until 1922 and in Canada until 1924 (table 1). Since then each year the number of sheep in both countries has increased. Along with this increasing number of sheep the trend in the purchasing power of sheep has been upward. The other types of livestock for only very short periods show an upward trend in price with increasing numbers. This upward trend in sheep prices was no doubt partly the result of comparatively good wool prices within recent years, due to the relative prosperity of the world compared with the period from 1921 to 1923. In this connection it is interesting to point out that there is an apparent correlation between Toronto sheep prices and the price of industrial stocks. There were severe breaks in stocks on the New Stock Market during the years 1893, 1899, 1903, 1907, 1919 and 1929. (*13*). Each time there is a major decline in stocks the sheep cycle apparently starts downward. The only exception appears to be in 1918 when wool prices preceded stocks in the downward trend by about a year.

Sheep prices started to weaken the latter part of 1929 and at the time of writing are 95 per cent of normal which is the first time they have been so low since 1922. With the heavy liquidation of sheep in Australia and the promise of heavy liquidation in the United States, largely due to world's stocks of wool being too great for the restricted demand we may expect sheep prices to be on the declining side of the cycle for at least two years.

Price Series Used

It is a difficult matter to obtain reliable prices on livestock in Canada for the years before 1910. However, since 1910 the Dominion Department of Agriculture has been reporting very reliable prices for the various livestock markets.

The price series from 1890 to 1909 for the three types of livestock were taken from a publication of the Dominion Bureau of Statistics, "Wholesale Prices, Canada 1890-1909". The prices in this publication were taken from the Toronto Globe and were quotations for the Toronto market on only the

first market day of each month. In most cases two figures are given, a high and a low. Where possible the writer used the average of these two figures for the monthly price. The hogs were quoted as "Choice Selects," the beef cattle as "Choice Steers," and the sheep as "Export Ewes". In the case of the sheep only the top quotations were used as they fitted in better than the average price with the price series used in later years.

From 1910 to 1920 the beef prices were for "Choice Steers" as reported by the Department of Agriculture, and from 1921 to 1929 the quotations were for "Good Steers—1000-1200 lbs." Hog prices from 1910 to 1922 were for "Selects" and from 1923 to 1929 for "Select Bacon". As there are no comparable Department of Agriculture prices for sheep from 1909 to 1913, the prices used during this period were the average monthly top prices for "Good Butcher Ewes" on the Toronto market as reported by the Farmer's Sun, a Toronto Farm paper. From 1914 to 1929 the price quotations were for "Good Lambs."

Method

The general method employed in constructing figures 1, 2, and 3 is somewhat like that used by the Harvard Economic Service in constructing their forecasting curves A. B. and C. (*14*). The method may be briefly summarized as follows:—

(1) Deflation of the price series used by dividing actual prices by the wholesale commodity index.

(2) Determination of monthly ordinates of secular trend of deflated prices.

(3) Determination of seasonal variation.

(4) Determination of normal monthly ordinate of secular trend by multiplying monthly ordinate of secular trend by seasonal variation index for the particular month.

(5) Determining deviations in prices from normal by subtracting actual monthly deflated price from normal deflated price.

(6) Expressing these price deviations as a per cent above or below the normal deflated price.

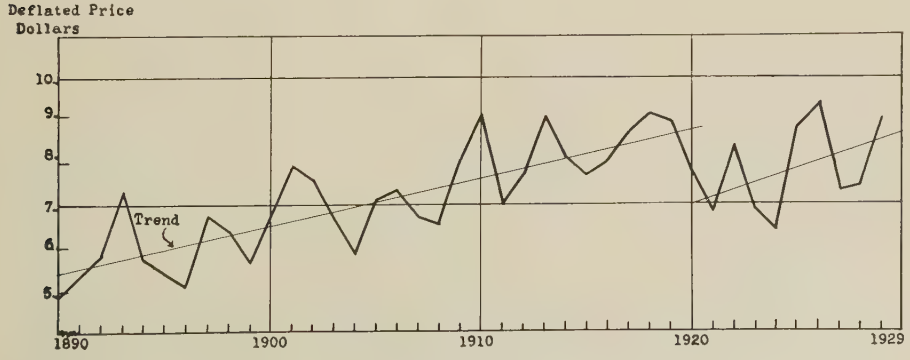

Figure 4. Average Yearly Deflated Price of Select Hogs, Toronto 1890-1929.

During the 40 years prices of hogs rose more rapidly than the general price level. From 1890 to 1920 the rise in the deflated price of hogs was at the rate of 1.6 per cent per annum of the average deflated price for the 31 years.

If the price curves were to be combined or compared with any other curves then the percentage deviations would have to be stated in units of their respective standard deviations (i.e. each individual percentage deviation would be divided by the standard deviation of the series).

In the case of the hog prices after deflating the average yearly prices it was found necessary to break the series up into two periods with a different trend line for each series (figure 4). The equation for the first period 1890 to 1920 was $Y = .1122X + 7.08$. From 1921 to 1929 the equation was $Y = .1655X + 7.81$. From these two equations the monthly ordinates of trend were calculated. The general price level as indicated by the wholesale index published by the Dominion Bureau of Statistics rose from 93 to 243 during the period 1890 to 1920 but the trend in the price of hogs during the same period rose more rapidly than the general price level hence we notice the decided upward trend in deflated hog prices.

Regarding seasonal variation it was thought that perhaps there might be a radical difference in the seasonal variation of hog prices during this 40 year period. Consequently the index of seasonal variation was calculated for the 10 year period 1890-99 and compared with a similar index for the period 1921-28 (figure 5). (The index of seasonal variation was calculated by the First Difference Method, described in any of the new statistical text books). The seasonal variation of the two periods did not differ radically. The chief difference noticed was that prices now tend to reach a higher peak during the later summer than formerly. In consequence of this small difference the two indexes were averaged and used thus for the whole series.

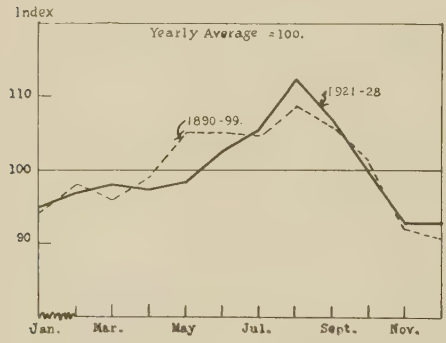

Figure 5. Changes in the Seasonal Variation of Prices of "Choice Select Hogs", 1890-1899, and Prices of "Select Hogs" 1921-1928. Toronto.

Hog prices now tend to rise to a greater extent in August than in earlier years.

For all three types of livestock, in calculating the actual monthly deflated price before obtaining the price deviations, the monthly actual prices were divided by the average yearly wholesale index number. However for the period 1916 to 1921 inclusive when prices were changing comparatively violently from month to month each monthly price was divided by the wholesale index for that month.

Because of the large amount of data, including 480 months for each series studied, only five years of data for each series have been included in this article. Table 2 illustrates the method of construction for figure 1. Under column 1 is the actual monthly price. Column 2 is the actual price divided by the wholesale index. Column 3 is the ordinates of secular trend by months.

TABLE 2.—*Cycles of deflated select hog prices at Toronto 1890-1920.*

Year	Actual Price	Deflated Price	Ordinates of Trend	Index of Seasonal Variation	Normal Deflated Price	Deviation from Normal	Per cent Deviation
	1	2	3	4	5	6	7
1890							
January	4.12	4.43	5.34	94.3	5.04	−.61	−12.1
February	4.12	4.43	5.35	97.5	5.22	−.79	−15.1
March	4.12	4.43	5.36	97.1	5.20	−.77	−14.8
April	4.50	4.84	5.37	98.2	5.26	−.42	− 8.0
May	4.87	5.24	5.38	101.7	5.47	−.23	− 4.2
June	5.20	5.59	5.39	103.8	5.59	0	0
July	5.12	5.50	5.40	105.0	5.67	−.17	− 3.0
August	5.12	5.50	5.41	110.5	5.98	−.48	− 8.0
September	5.25	5.64	5.42	106.5	5.77	−.13	− 2.3
October	5.13	5.51	5.43	100.6	5.46	+.05	+1.0
November	3.90	4.19	5.44	92.4	5.03	−.84	−16.7
December	4.07	4.38	5.45	92.0	5.01	−.63	−12.6
1891							
January	4.12	4.51	5.46	94.3	5.15	−.64	−12.4
February	4.37	4.78	5.47	97.5	5.33	−.55	−10.3
March	4.50	4.92	5.48	97.1	5.32	−.40	− 7.5
April	4.70	5.14	5.49	98.2	5.39	−.25	4.6
May	5.38	5.89	5.50	101.7	5.59	+.30	+5.4
June	5.38	5.89	5.50	103.8	5.71	+.18	+3.2
July	5.40	5.91	5.51	105.0	5.79	+.12	+2.1
August	5.63	6.16	5.52	110.5	6.10	+.06	+1.0
September	5.38	5.89	5.53	106.5	5.89	0	0
October	5.06	5.54	5.54	100.6	5.57	−.03	− .5
November	3.85	4.21	5.55	92.4	5.13	−.92	−17.9
December	4.12	4.51	5.56	92.0	5.12	−.61	−11.9
1892							
January	4.15	4.81	5.57	94.3	5.25	−.44	− 8.4
February	4.27	4.95	5.58	97.5	5.44	−.49	− 9.0
March	4.60	5.34	5.59	97.1	5.43	−.09	− 1.7
April	5.12	5.94	5.60	98.2	5.50	+.44	+ 8.0
May	5.55	6.44	5.61	101.7	5.71	+.73	+12.8
June	4.87	5.65	5.62	103.8	5.83	−.18	− 3.1
July	5.45	6.32	5.62	105.0	5.90	+.42	+ 7.1
August	5.67	6.58	5.63	110.5	6.22	+.36	+ 5.8
September	5.27	6.11	5.64	106.5	6.01	+.10	+ 1.7
October	4.95	5.74	5.65	100.6	5.68	+.06	+ 1.1
November	5.20	6.03	5.66	92.4	5.23	+.80	+15.3
December	5.20	6.03	5.67	92.0	5.22	+.81	+15.5
1893							
January	5.88	6.90	5.68	94.3	5.36	+1.54	+28.7
February	6.75	7.92	5.69	97.5	5.55	+2.37	+42.7
March	6.87	8.07	5.70	97.1	5.53	+2.54	+45.9
April	5.88	6.90	5.71	98.2	5.61	+1.29	+22.9
May	6.87	8.07	5.72	101.7	5.82	+2.25	+38.6
June	6.62	7.77	5.73	103.8	5.95	+1.82	+30.5
July	6.55	7.69	5.74	105.0	6.03	+1.66	+27.5
August	6.37	7.48	5.75	110.5	6.35	+1.13	+17.7
September	6.17	7.24	5.76	106.5	6.13	+1.11	+18.1
October	6.05	7.10	5.77	100.6	5.80	+1.30	+22.4
November	5.55	6.52	5.78	92.4	5.34	+1.18	+22.1
December	5.07	5.95	5.79	92.0	5.33	+ .62	+11.63
1894							
January	4.87	6.04	5.80	94.3	5.47	+.57	+10.4
February	4.65	5.77	5.81	97.5	5.66	+.11	+ 1.9
March	4.37	5.42	5.82	97.1	5.65	− .23	− 4.1
April	4.35	5.40	5.83	98.2	5.72	− .32	− 5.6
May	4.68	5.81	5.84	101.7	5.94	− .13	− 2.2
June	4.62	5.73	5.85	103.8	6.07	− .34	− 5.6
July	4.63	5.75	5.86	105.0	6.15	− .40	− 6.5
August	4.95	6.14	5.86	110.5	6.48	− .34	− 5.2
September	5.12	6.35	5.87	106.5	6.25	+.10	+ 1.6
October	4.95	6.14	5.88	100.6	5.92	+.22	+ 3.7
November	4.27	5.30	5.89	92.4	5.44	− .14	− 2.6
December	3.88	4.81	5.90	92.0	5.43	− .62	11.4

Column 4 is the index of seasonal variation. Column 5 is the normal deflated price obtained by multiplying column 3 by column 4. Column 6, deviations from normal, is obtained by subtracting column 5 from column 2. The final column, percentage deviation, is obtained by expressing column 6 as a percentage of column 5 keeping the same algebraic signs as column 6. Thus in figures 1 and 2 the monthly prices with seasonal variation removed are expressed as percentage deviations above and below the long time trend.

The deflated beef prices presented a little different problem. Although the deflated beef prices had a decided upward trend until 1920 yet the trend was not as uniform as that of hog prices. It was found that a straight line fitted to the data would not give a true picture of the price changes. Also a mathematically fitted curve would not describe the relationship. Consequently a large scale chart was constructed (about 6 ft. long) and a free-hand curve fitted bearing in mind the theory of least squares, (the sum of the squares of the deviations from the line must be a minimum.) The result is shown in figure 6. The trend line for the last 8 years was taken as the average of the yearly average deflated prices from 1922 to 1929.

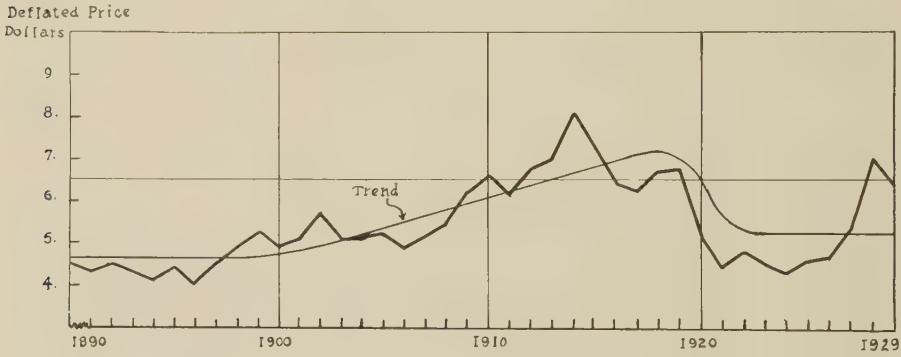

Figure 6. Average Yearly Deflated Price of Steers, Toronto 1890-1929. (1890-1920 Choice Steers, 1921-1929-Good Steers 1000-1200 lbs.).

From 1890 to 1920 prices of beef cattle rose more rapidly than the general price level. The deflation in 1920 coming at a time when there was a large cattle population caused a very severe depression in the beef industry.

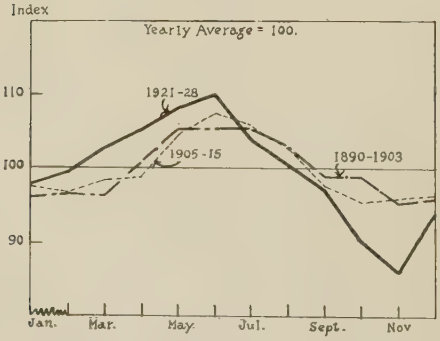

Figure 7. Changes in the Seasonal Variation in Price for Steers, Toronto 1890-1929.

Due to the influence of Western cattle production, prices now tend to fluctuate more violently within the year than during the period 1890-1903.

The seasonal variation for beef cattle prices was calculated for three periods, 1890-1903, 1905-1915, and 1921-1928. (figure 7). It will be noticed that the seasonal variation in prices has tended to become more violent since

1890. This is probably due to the present heavy fall marketing of western cattle in Canada compared with that of many years ago. The seasonal variation index for 1890-1903 was applied to the data from 1890-1904. The index for 1905-1915 was applied to the data for the same period. For the war period 1916 to 1920 the index of seasonal variation used was an average of the two indexes 1905-1915 and 1921-1928. From 1921 to 1929 the index for that period was used.

The deflated prices for butcher sheep from 1890 to 1898 showed a downward trend and from 1898 to 1918 an upward trend (figure 8). The first straight line fitted was for the period 1890 to 1898, the equation being $Y = -.297X + 5.27$. For the period 1899 to 1913 the equation of the line of trend was $Y = .094X + 4.83$. From 1914 to 1929 the price series used was that for Good Lambs. As this short period gave no indications of any definite trend, the trend or normal line used was simply an average of the yearly prices for this period. As the prices of both these grades of sheep were expressed as percentage deviations from the normal price no difficulty was encountered in joining up the price series.

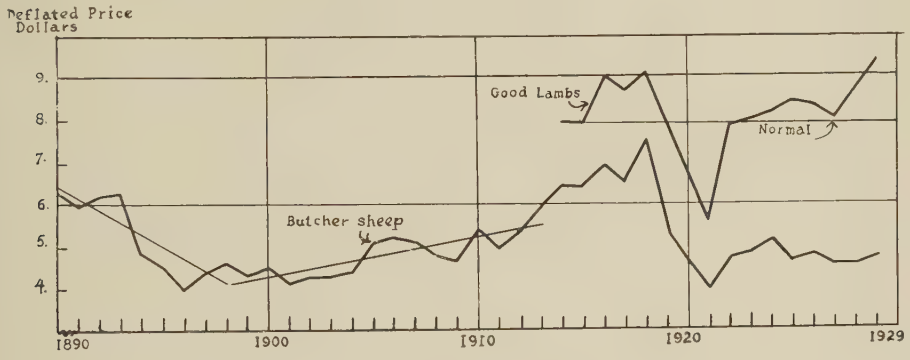

Figure 8. Average Yearly Deflated Price of Sheep, Toronto, 1890-1929. (Butcher Sheep 1890-1929, Good Lambs 1914-1929)

From 1895 to 1918 the price of butcher sheep rose more rapidly than the general price level. Since the violent deflation in 1920 the deflated price of butcher sheep has not reached the 1918 level. Largely due to the increased purchasing power, because of the lag in wages since 1920, the deflated price of good lambs in 1928 reached the level of 1918.

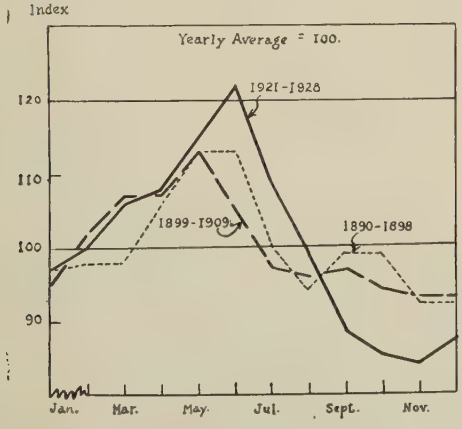

Figure 9. Changes in the Seasonal Variation of the Price of Sheep, Toronto 1890-1929. (1890-1909 Export ewes, 1921-1928 Good Lambs).

Prices of Good Lambs have a more violent seasonal fluctuation than Export Ewes from 1890 to 1909. The seasonal variation in lamb prices is more pronounced than either Good Steers or Select Hog Prices on the Toronto Market.

TABLE 3.—*Cycles of deflated beef cattle prices at Toronto 1890-1929 (1890-1909-Choice Steers)*

Year	Actual Price	Deflated Price	Ordinates of trend	Index of Seasonal Variation	Normal Deflated Price	Deviation from Normal	Per cent Deviation
	1	2	3	4	5	6	7
1902							
January	4.27	4.95	4.95	96	4.77	+ .18	+ 3.8
February	4.50	5.22	4.95	96	4.78	+ .44	+ 9.2
March	4.37	5.07	4.96	97	4.80	+ .27	+ 5.6
April	4.37	5.07	4.97	101	5.02	+ .05	+ 1.0
May	5.72	6.64	4.98	105	5.25	+1.39	+26.5
June	5.72	6.64	5.00	106	5.28	+1.36	+25.7
July	5.50	6.38	5.02	106	5.30	+1.08	+20.4
August	5.62	6.52	5.03	103	5.19	+1.33	+25.6
September	4.75	5.51	5.04	99	4.97	+ .54	+10.9
October	4.87	5.65	5.05	99	4.99	+ .66	+13.2
November	4.70	5.45	5.06	96	4.84	+ .61	+12.6
December	4.50	5.22	5.07	96	4.86	+ .36	+ 7.4
1903							
January	4.75	5.47	5.08	96	4.89	+ .58	+11.9
February	4.50	5.18	5.09	96	4.91	+ .29	+ 5.9
March	3.90	4.49	5.10	97	5.02	− .53	−10.6
April	4.30	4.95	5.12	101	5.18	− .23	− 4.4
May	4.62	5.32	5.13	105	5.41	− .09	− 1.7
June	4.75	5.47	5.14	106	5.43	+ .04	+ 0.7
July	4.80	5.52	5.15	106	5.44	+ .08	+ 1.4
August	4.67	5.38	5.16	103	5.32	+ .06	+ 1.1
September	4.40	5.06	5.17	99	5.10	− .04	− .8
October	4.45	5.12	5.18	99	5.12	0	0
November	4.30	4.95	5.19	96	4.97	− .02	− .4
December	4.30	4.95	5.20	96	4.98	− .03	− .4
1904							
January	4.37	5.02	5.22	96	5.03	− .01	− .2
February	4.37	5.02	5.23	96	5.05	− .03	− .6
March	4.37	5.02	5.24	97	5.07	− .05	− 1.0
April	4.70	5.40	5.25	101	5.31	+ .09	+ 1.8
May	4.57	5.25	5.26	105	5.54	− .19	− 3.4
June	4.70	5.40	5.27	106	5.57	− .17	− 3.3
July	4.90	5.63	5.29	106	5.59	+ .04	+ 0.7
August	4.57	5.25	5.30	103	5.46	− .21	− 3.8
September	4.42	5.08	5.31	99	5.24	− .16	− 3.0
October	4.25	4.88	5.32	99	5.26	− .38	− 7.2
November	4.40	5.06	5.33	96	5.10	− .04	− 0.8
December	4.37	5.02	5.34	96	5.12	− .10	− 1.9
1905							
January	4.25	4.84	5.35	97	5.19	− .35	− 6.7
February	4.17	4.75	5.37	97	5.21	− .46	− 8.8
March	4.32	4.92	5.38	99	5.33	− .41	− 7.7
April	4.62	5.26	5.39	99	5.34	− .08	− 1.5
May	5.52	6.29	5.40	105	5.67	+ .62	+10.9
June	5.37	6.12	5.41	107	5.79	+ .33	+ 5.7
July	5.05	5.75	5.42	106	5.75	0	0
August	4.57	5.21	5.43	103	5.59	− .38	− 6.8
September	4.30	4.90	5.44	98	5.34	− .44	− 8.2
October	4.20	4.78	5.46	96	5.24	− .46	− 8.8
November	4.15	4.73	5.47	96	5.25	− .52	−10.0
December	4.25	4.84	5.48	97	5.32	− .48	− 9.0
1906							
January	4.50	4.86	5.49	97	5.33	− .47	− 8.8
February	4.50	4.86	5.50	97	5.33	− .47	− 8.8
March	4.62	4.90	5.52	99	5.46	− .56	−10.2
April	4.52	4.88	5.53	99	5.47	− .59	−10.8
May	4.87	5.26	5.54	105	5.82	− .56	− 9.6
June	4.65	5.02	5.55	107	5.94	− .92	−15.5
July	4.62	4.90	5.56	106	5.89	− .99	−16.8
August	4.50	4.86	5.57	103	5.74	− .88	−15.3
September	4.52	4.88	5.58	98	5.47	− .59	−10.8
October	4.12	4.45	5.59	96	5.37	− .92	−17.1
November	4.37	4.72	5.60	96	5.38	− .66	−12.3
December	4.40	4.75	5.62	97	5.45	− .70	−12.8

TABLE 4.—*Cycles of deflated sheep prices at Toronto 1890-1930. (1914-1929—Good Lambs.)*

Year	Actual Price	Deflated Price	Average Deflated Price	Index of Seasonal Variation	Normal Deflated Price	Percent of Normal Deflated Price	37 months Moving Average
	1	2	3	4	5	6	7
1914							
January	8.91	8.71	7.97	97	7.73	112.7	100.7
February	9.30	9.09	7.97	100	7.97	113.9	100.8
March	9.44	9.23	7.97	106	8.45	109.2	100.6
April	8.91	8.71	7.97	108	8.61	101.1	101.3
May	8.22	8.03	7.97	115	9.17	87.6	102.3
June	7.50	7.33	7.97	122	9.72	75.4	103.2
July	8.42	8.23	7.97	108	8.61	95.6	103.6
August	7.75	7.58	7.97	99	7.89	96.0	103.5
September	7.22	7.06	7.97	88	7.01	100.7	103.6
October	6.71	6.56	7.97	85	6.77	96.9	103.4
November	7.30	7.14	7.97	84	6.69	106.7	103.1
December	8.22	8.03	7.97	87	6.93	115.9	103.3
1915							
January	8.00	7.28	7.97	97	7.73	94.2	103.7
February	7.95	7.23	7.97	100	7.97	90.6	103.9
March	9.05	8.23	7.97	106	8.45	97.4	104.2
April	9.00	8.19	7.97	108	8.61	95.1	104.6
May	8.85	8.05	7.97	115	9.17	87.8	105.0
June	9.30	8.46	7.97	122	9.72	87.0	105.4
July	9.75	8.87	7.97	108	8.61	103.0	105.5
August	9.15	8.33	7.97	99	7.89	105.5	105.6
September	7.57	6.89	7.97	88	7.01	101.8	105.3
October	8.30	7.56	7.97	85	6.77	111.7	105.1
November	8.80	8.01	7.97	84	6.69	119.7	104.9
December	8.70	7.92	7.97	87	6.93	114.3	105.0
1916							
January	10.75	8.78	7.97	97	7.73	113.6	105.4
February	11.40	9.23	7.97	100	7.97	115.6	105.6
March	12.40	10.08	7.97	106	8.45	119.2	106.4
April	12.45	10.13	7.97	108	8.61	117.6	107.2
May	12.60	10.05	7.97	115	9.17	109.6	108.1
June	13.90	10.94	7.97	122	9.72	112.6	108.9
July	13.65	10.73	7.97	108	8.61	124.6	109.0
August	11.75	8.93	7.97	99	7.89	113.1	109.9
September	10.10	7.49	7.97	88	7.01	110.6	110.5
October	10.70	7.58	7.97	85	6.77	111.9	111.1
November	11.05	7.38	7.97	84	6.69	113.3	111.7
December	11.40	7.61	7.97	87	6.93	109.8	112.0
1917							
January	13.98	8.86	7.97	97	7.73	114.6	112.9
February	14.62	9.09	7.97	100	7.97	113.9	113.4
March	14.56	8.82	7.97	106	8.45	104.3	114.0
April	15.11	8.74	7.97	108	8.61	101.5	114.4
May	16.10	8.64	7.97	115	9.17	94.2	114.0
June	16.09	8.67	7.97	122	9.72	89.2	113.5
July	14.74	7.96	7.97	108	8.61	92.4	113.1
August	15.14	8.10	7.97	99	7.89	102.6	112.7
September	15.35	8.43	7.97	88	7.01	124.5	112.4
October	16.28	8.89	7.97	85	6.77	131.3	112.4
November	16.24	8.72	7.97	84	6.69	130.4	111.6
December	17.58	9.36	7.97	87	6.93	135.1	111.5
1918							
January	18.55	9.68	7.97	97	7.73	125.2	111.2
February	18.52	9.64	7.97	100	7.97	120.8	110.6
March	19.07	9.81	7.97	106	8.45	116.1	110.0
April	20.23	10.37	7.97	108	8.61	120.4	109.7
May	20.47	10.52	7.97	115	9.17	114.7	109.2
June	18.84	9.61	7.97	122	9.72	98.9	108.9
July	20.87	10.46	7.97	108	8.61	121.4	108.7
August	19.53	9.63	7.97	99	7.89	122.0	108.4
September	17.26	8.42	7.97	88	7.01	124.4	107.9
October	16.32	7.89	7.97	85	6.77	116.5	107.4
November	13.87	6.69	7.97	84	6.69	100.0	106.6
December	14.37	7.00	7.97	87	6.93	101.0	106.2

TABLE 5.—*Index of seasonal variation for price of hogs, beef cattle and sheep, 1890 to 1928.*

Month	Choice Select Hogs 1890-1899	Select Bacon Hogs 1921-1928	Choice Steers 1890-1903	Choice Steers 1905-1915	Good Steers 1921-1928	Export Ewes 1890-1898	Export Ewes 1899-1909	Good Lambs 1922-1929
January	94	95	96	97	98	97	95	97
February	98	97	96	97	100	98	102	100
March	96	98	97	99	103	98	107	106
April	99	98	101	99	105	106	107	108
May	105	98	105	105	108	113	113	115
June	105	103	106	107	110	113	105	122
July	104	106	106	106	104	100	97	108
August	109	112	103	103	101	94	96	99
September	106	107	99	98	97	99	97	88
October	101	100	99	96	91	99	94	85
November	92	93	96	96	86	92	93	84
December	91	93	96	97	97	92	93	87

By referring to figure 8 the reader will obtain a graphic idea of how the relatively poorer classes of livestock were in relatively greater demand than the better quality during the period of rapidly rising prices and low buying power of the people. However, it will be noticed that since the deflation period Good Lambs reached their 1918 purchasing power but Butcher Sheep have never approached the 1918 level. This spread is undoubtedly due to the lag in wages and consequent greater demand for all of the best quality goods.

Seasonal variation in the price of sheep exhibits the same tendency as the other types of livestock. That is, the violence of the yearly fluctuation appears to be increasing (figure 9). However, this statement regarding sheep must be made with reservations as the comparison on the chart is made between different classes of sheep.

In removing the seasonal variation in sheep prices for the period 1890 to 1898 the seasonal index for that period was used. For the period 1899 to 1913 the seasonal index calculated for the 1899-1909 period was used. From 1914 to 1929 the seasonal index for the period 1922-1929 was used.

Table 3 is a sample of the method used in constructing figure 2. The explanation of this table is the same as that applied to Table 2. In Table 4 we have a slightly different method of constructing the final figure 3. The data is just for the Lamb price period 1914 to 1929. It will be noticed that column 3 (Table 4) instead of being labeled Ordinates of Trend is labeled Average Deflated Price. This indicates that there was no definite trend for the period, therefore the normal price was the average for the period 1914 to 1929. Instead of expressing the price deviations as a certain percentage above and below the trend or normal, the price was expressed as a certain percentage *of* the trend or normal price. In other words column 6 is column 2 divided by column 5 and multiplied by 100. This method facilitated the construction of the 37 month's moving average.

SUMMARY

Although there are some unavoidable variations in the price classifications of the data used, yet it is thought that had any other worker used the

same data the conclusions in general would not differ materially from those presented. Some limitations of the data are evident. The price series are not truly continuous. In the early years the monthly prices are taken only as on the first market day of each month. On the other hand the more recent prices taken from the publications of the Livestock Branch of the Department of Agriculture are weighted monthly averages of every market day during the month. Also when it comes to fitting straight line trends, or drawing a free hand curve to fit the data, the personal element or the judgement of the investigator enters into the problem. However, as suggested above, the writer does not think that the results presented in this study would vary very much from the results to be obtained by any other worker handling the same data.

This study of livestock prices in Canada since 1890 would appear to warrant the following conclusions:—

(1) During the period 1890 to 1920 the prices for hogs, cattle and sheep tended to rise more rapidly than the general level of all prices.

(2) The hog cycle appears to be about 4 to 5 years from peak to peak. A major cycle is followed by a minor cycle.

(3) The beef cattle cycle appears to be about 14 years from peak to peak.

(4) The sheep cycle is not as regular as the cycle for the other types of livestock. It varies from 5 to 8 years from peak to peak. There appears to be a relation between the sheep cycle in Canada and the price of stocks.

(5) The seasonal variation in the price of all three classes of livestock appears to be more violent within recent years. This tendency is not so marked in the case of hogs.

(6) The hog cycle is approaching and is close to the peak.

(7) The beef cycle is receding. The trend will probably be downward for 4 to 5 years.

(8) The sheep cycle is receding. The trend will probably be downward for 2 years.

Since June 1st when the above article was written, the level of all commodity prices throughout the world has suffered a drastic decline, approaching the severe deflation in 1920. Although beef prices have dropped considerably the industry is fortunate in that it is not in the same stage of the cycle as it was in 1920. At the end of August beef prices had dropped to about 4 per cent below the normal line as shown in figure 2. Most of this drop to date has been due to decreased demand, for during the first seven months of this year 317,169 head of cattle were slaughtered at the Government inspected plants, whereas last year for the same period 345,670 were slaughtered. Due to the change in the world level of all prices beef cattle prices at the bottom of the swing of the present cycle will probably reach the peak of the cycle somewhat sooner than the writer anticipated. The peak of the cycle was reached in March of this year when the price was 16 per cent above the normal line as shown in figure 2. At the end of August the

price had receded to the normal line. Reports at hand indicate that the number of hogs in Europe and the United States is steadily increasing. At the end of August the price of good lambs had dropped drastically to a new low level, being 87 per cent of normal as indicated by figure 3. The world is oversupplied with wool and mutton. It is quite likely that the bottom of the sheep cycle will see prices lower than in 1921 when in November of that year the average price for good lambs at Toronto was $8.35.

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EFFECT OF TEMPERATURE ON HOST REACTIONS TO PHYSIOLOGIC FORMS OF *PUCCINIA GRAMINIS AVENAE*, ERIKSS. & HENN.*

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Introduction

Since the study of physiologic forms of *Puccinia graminis avenae* Erikss. & Henn. was commenced at the Dominion Rust Research Laboratory, Winnipeg, in 1925, it has been noted at various times, particularly during the summer months, that the reaction of one differential host, Joanette Strain, to certain physiologic forms fluctuated beyond the normal limits. This was considered to be due partly to a genetic instability of this differential host and partly to the high temperature prevailing in the greenhouses during the summer. In 1929, temperature control apparatus was installed in two sections of one of the greenhouses. A study of the effect of temperature on the reactions of the differential hosts was thus made possible.

Historical

That temperature exerts a decided influence on the development of cereal rusts has been observed by numerous workers, including Christman (*2*), Freeman and Johnson (*3*), Fromme (*4*), Hecke (*5*), Hungerford (*6*) Lauritzen (*7*), Mains (*8*), Metha (*9*), Peltier (*10*), Stakman and Levine (*11*), and Ward (*12, 13*). Their observations or investigations dealt largely, however, with the effect of temperature on the amount of infection and the duration of the incubation period of the different cereal rusts. Waterhouse (*14*), in Australia, showed that changes in temperature affected the reactions of one differential host to certain physiologic forms of *Puccinia graminis avenae*. He found that Joanette Strain was resistant to Form 1 in the winter, susceptible to it in the summer, and gave a heterogeneous reaction in the spring and fall, but the reaction of this host to physiologic forms 2 and 7 throughout the year was not significantly changed.

Effect of Four Temperatures on the Reactions of the Differential Hosts to Eight Physiologic Forms

The effect of temperature on the reactions of the differential hosts to physiologic forms of *Puccinia graminis avenae* was studied in the following manner. A single spore culture of each of the eight physiologic forms was first obtained, and cultures derived from these single spores were used as inoculum throughout the study. The differential hosts, White Russian, Richland, Joanette Strain, and Victory were inoculated in the seedling stage, kept for 48 hours in moist chambers at the ordinary greenhouse temperature, and then placed in sections of the greenhouse which were maintanied at approximately constant temperatures. The reactions of the differential hosts to the eight physiologic forms were determined at four temperatures, 57.4° 64.8°, 71.9° and 75.4°F. These were the mean temperatures for the sections

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of the greenhouse during the complete development of the uredinial stage of the rust. Above or below each of these temperatures, the variation was not more than 2 degrees. During the winter months, the daylight was supplemented by artificial light at night.

The classes of host reaction and infection types used by Bailey (*1*) have been followed. They are as follows:

Classes of Host Reaction	Types of Rust Infection
Practically immune	0; No uredinia developed, but sharply defined hypersensitive flecks present.
Extremely resistant	1. Infection very light; uredinia minute, scattered, and surrounded by sharply defined necrotic areas.
Moderately resistant	2. Infection light; uredinia usually small and scattered, hypersensitive areas varying from sharply defined necrosis to pronounced chlorosis.
Moderately susceptible	3. Infection moderate; uredinia mid-sized with a tendency to coalesce; true hypersensitiveness absent, but more or less well marked chlorosis present.
Completely susceptible	4. Infection normal and heavy; uredinia large, numerous, and confluent; hypersensitiveness absent, but chlorosis may be present.
Indeterminate	X. Uredinia very variable, apparently including all types of infection, often on the same leaf-blade; no mechanical separation of the types seems possible, and the infection is ill-defined and heterogeneous.

Under these conditions, it was shown that temperature influences very definitely the reaction of a differential host to certain physiologic forms of *Puccinia graminis avenae*. There was no significant difference in the reactions of the differential hosts, White Russian, Richland, and Victory, to any of the physiologic forms at these temperatures. However, the reaction of Joanette Strain to forms 1, 3, 4, and 5, was decidedly changed. The reaction of this differential host to these four forms at the four temperatures is shown for one test in Table 1. Other tests with this differential host at the four temperatures already mentioned gave essentially the same results. The reaction of this differential host to forms 2, 6, 7, and 8, was not significantly affected by the higher temperatures.

The reactions given in Table 1 are to be interpreted as follows: The number below the line denotes the total number of plants inoculated; the number above the line and placed just before the bracketed number denotes the number of plants giving the type of reaction enclosed by the brackets; and the number which appears after a semicolon denotes the number of plants which are flecked. For example, the reaction of Joanette Strain at 75.4°F.

to physiologic form 1 in Table 1 denotes that, out of a total of thirteen plants inoculated, two plants gave a (4) type of reaction indicating complete susceptibility, while eleven plants gave a (3) type of reaction, indicating moderate susceptibility.

TABLE 1. *The reaction of Joanette Strain to Physiologic forms 1, 3, 4, and 5, at four different Temperatures.*

Form	Temperatures			
	75.4° F.	71.9° F.	64.8° F.	57.4° F.
1	$\frac{2(4)c11(3)cn^{-\ \pm}}{13}$	$\frac{1(4)2(X)5(1)\pm}{10}$	$\frac{1(4)11(X)3(1)}{15}$	$\frac{11(1)-;2}{14}$
3	$\frac{13(4)cnl(3)cn^{=\ -}}{14}$	$\frac{5(3)cn6(X)cn^{\pm}}{12}$	$\frac{6(X)-10(1)\pm}{16}$	$\frac{1(1)-;6}{7}$
4	$\frac{10(4)c^{+}}{10}$	$\frac{12(4)cn^{\pm}}{12}$	$\frac{7(3)\pm4(X)1(1)}{14}$	$\frac{2(1)-;11}{14}$
5	$\frac{12(4)+}{12}$	$\frac{17(4)\pm}{17}$	$\frac{16(4)}{16}$	$\frac{11(X)-2(4)-}{16}$

Explanation of Symbols: Plus and minus signs indicate a slightly greater or less amount of rust than the nearest figure representing the infection type. The semicolon indicates the presence of flecks. The sign "cn" indicates that hyper-sensitiveness ranging from chlorosis to necrosis typically accompanies the infection. These symbols are also used in Tables 3-10.

According to the analytic key for the identification of physiologic forms of *P. graminis avenae* prepared by Bailey (*1*), Joanette Strain is resistant to forms 1, 3, and 4, and gives a heterogeneous (X) reaction to form 5. It will be seen from Table 1 that, at 57.4°F., this host reacts normally to these forms; but, at the higher temperatures, its reactions are heterogeneous and abnormal. Thus it would appear that only at a comparatively low temperature do these forms produce on Joanette Strain the characteristic reactions which have hitherto served, in part, for their identification as forms 1, 3, 4, and 5. These forms, at the higher temperatures, do not produce these reactions, but instead, reactions which may be identical with those of other forms. In Table 2 are given the forms under which forms 1, 3, 4, and 5 would be classified at the four temperatures.

TABLE 2. *Changes in the identification of physiologic forms 1, 3, 4 and 5, due to the effect of temperature on the reaction of the differential host, Joanette Strain.*

Form	Temperatures			
	75.4° F.	71.9° F.	64.8° F.	57.4° F.
1	2	5	5	1
3	7	new form	new form	3
4	6	6	same new form	4
5	2	2	2	5

The reaction shown by the differential host, Joanette Strain, to physiologic form 4 at the temperatures 57.4° and 75.4°F., is shown by means of a photograph in Fig. 1. This host was extremely resistant when kept at 57.4° and was completely susceptible at 75.4°F.

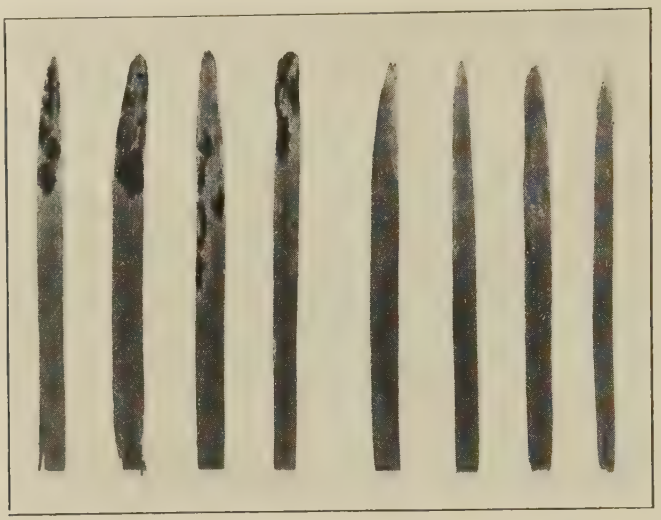

Figure 1. The reaction of Joanette Strain to Form 4 at temperatures of 57.4°F. (right), and at 75.4°F. (left).

Effect of a Change in Temperature on the Reaction of Joanette Strain to Four Physiologic Forms

A further study was made to determine the effect on the reaction of Joanette Strain to forms 1, 3, 4, and 5, when the temperature at which it was kept during the development of the rust was changed. Seedlings of Joanette Strain growing in pots were inoculated and then placed in moist chambers for 48 hours at the ordinary greenhouse temperature. Eighteen pots were inoculated with each of these forms. Nine pots were placed in a section of the greenhouse maintained at a low temperature (60.8°F.), and nine in a section maintained at a high temperature (76.8°F.). After one day, and on each succeeding day for seven days, one pot was transferred from the low to the high temperature, and one from the high to the low temperature. One pot was kept as a control in each section. The results of this experiment are given in Table 3-10.

It is evident from Tables 3-10 that Joanette Strain gave a very heterogeneous reaction to forms 1, 3, 4, and 5, when the temperature at which it was kept during the development of the rust was changed. The longer the period Joanette Strain was kept at a temperature of 60.8°F. during the development of the rust before it was transferred to a temperature of 76.8°F., the greater was the resistance it showed (Tables 3, 5, 7, 9). Conversely, the longer the period this host was kept at a temperature of 76.8°F., during the development of the rust before it was transferred to a temperature of 60.8°F., the greater was its susceptibility (Tables 4, 6, 8, 10). When kept at a temperature of 60.8°F., during the complete development of the

TABLE 3. *The reaction of Joanette Strain to form 1 when kept for different lengths of time at a temperature of 60.8° F. and then transferred to a temperature of 76.8° F.*

Kept 1 day at 60.8° F	$\frac{6(4)cn6(X)1(1)+}{13}$
" 2 days "	$\frac{5(X)9(1)}{14}$
" 3 " "	$\frac{2(X)6(1)}{9}$
" 4 " "	$\frac{10(X)1(1)}{13}$
" 5 " "	$\frac{3(X)5(1),1}{10}$
" 6 " "	$\frac{2(X)-6(1):2}{11}$
" 7 " "	$\frac{3(X)-6(1)=;4}{14}$
Kept continuously at 60.8° F	$\frac{1(X)=6(1)-;1}{9}$
Kept continuously at 76.8° F	$\frac{3(4)cn2(1)+}{7}$

TABLE 4. *The reaction of Jaonette Strain to form 1 when kept for different lengths of time at a temperature of 76.8° F. and then transferred to a temperature of 60.8° F.*

Kept 1 day at 76.8° F	$\frac{3(X)=4(1)-;2}{9}$
" 2 days "	$\frac{2(X)=5(1)-}{7}$
" 3 " "	$\frac{3(1)-5(1)\pm}{8}$
" 4 " "	$\frac{\pm 6(3)cn3(X)-}{10}$
" 5 " "	$\frac{\pm 5(3)cn2(X)}{7}$
" 6 " "	$\frac{\pm 7(3)cn2(X)}{9}$
" 7 " "	$\frac{\pm 8(3)cn8(X)}{16}$
Kept continuously at 76.8° F	$\frac{-\ \pm 1(4)c3(3)cn2(X)1(1)}{8}$
Kept continuously at 60.8° F	$\frac{1(X)=4(1)-;2}{8}$

TABLE 5. *The reaction of Joanette Strain to form 3 when kept for different lengths of time at a temperature of 60.8° F. and then transferred to a temperature of 76.8° F.*

Kept 1 day at 60.8° F	$\frac{\pm 4(c)cn3(X)-6(1)}{15}$
" 2 " "	$\frac{+ 1(3)cn6(1)-;6}{14}$
" 3 " "	$\frac{1(1)-;7}{10}$
" 4 " "	$\frac{1(1)-;10}{11}$
" 5 " "	$\frac{1(1)-;10}{14}$
" 6 " "	$\frac{0;11}{15}$
" 7 " "	$\frac{0;7}{14}$
Kept continuously at 60.8° F	$\frac{0;3}{8}$
Kept continuously at 76.8° F	$\frac{-6(4)cn4(X)}{11}$

TABLE 6. *The reaction of Joanette Strain to form 3 when kept for different lengths of time at a temperature of 76.8° F. and then transferred to a temperature of 60.8° F.*

Kept 1 day at 76.8° F	$\frac{3(1)=;9}{12}$
" 2 " "	$\frac{+ 1(X)-14(1)-;1}{16}$
" 3 " "	$\frac{8(X)-4(1)\pm}{12}$
" 4 " "	$\frac{\pm 1(3)cn9(X)}{12}$
" 5 " "	$\frac{\pm 1(3)cn6(X)1(1)}{8}$
" 6 " "	$\frac{\pm 4(3)cn5(X)}{10}$
" 7 " "	$\frac{\pm 4(3)cn4(X)}{8}$
Kept continuously at 76.8° F	$\frac{1(4)7(3)+cnl(X)}{10}$
Kept continuously at 60.8° F	$\frac{0;7}{10}$

TABLE 7. *The reaction of Joanette Strain to form 4 when kept for different lengths of time at a temperature of 60.8° F. and then transferred to a temperature of 76.8° F.*

Kept 1 day at 60.8° F	1(4)c4(3)+6(X) / 12
" 2 " "	3(3)+6(X)+ / 10
" 3 " "	5(X)6(1)+ / 11
" 4 " "	1(3)+6(X)−4(1) / 12
" 5 " "	1(X)−4(1)−;6 / 12
" 6 " "	1(X)−6(1)−;5 / 13
" 7 " "	1(X)=3(1)−;7 / 7
Kept continuously at 60.8° F	5(1)=;5 / 10
Kept continuously at 76.8° F	13(4)+5(X)+ / 18

TABLE 8. *The reaction of Joanette Strain to Form 4 when kept for different lengths of time at a temperature of 76.8° F., and then transferred to a temperature of 60.8° F.*

Kept 1 day at 76.8° F	7(1)−;1 / 9
" 2 " "	4(1)−1(X)=;2 / 9
" 3 " "	7(1)4(X)=;1 / 13
" 4 " "	2(1)6(X)1(3)c+ / 10
" 5 " "	1(4)2(X)3(1);2 / 10
" 6 " "	3(4)5(X)+ / 8
" 7 " "	5(4)3(3)c1(X)+ / 10
Kept continuously at 76.8° F	9(4)±1(X)+ / 10
Kept continuously at 60.8° F	4(1)−;3 / 8

TABLE 9. *The reaction of Joanette Strain to form 5 when kept for different lengths of time at a temperature of 60.8° F., and then transferred to a temperature of 76.8° F.*

Kept 1 day at 60.8° F	14(4) $\overset{+}{-}$ / 14
" 2 " "	11(4)c / 11
" 3 " "	9(4)c 1(X)+ / 11
" 4 " "	5(4)c 2(3)cn $\overset{-}{}$ / 7
" 5 " "	10(4)c 2(X) $\overset{-}{}$ / 13
" 6 " "	1(4)c 8(X) $\overset{-}{}$ / 9
" 7 " "	6(X) 1(1) / 9
Kept continuously at 60.8° F	7(X) 2(4)cn $\overset{=}{}$ / 9
Kept continuously at 76.8° F	12(4)c $\overset{+}{}$ / 12

TABLE 10. *The reaction of Joanette Strain to form 5 when kept for different lengths of time at a temperature of 76.8° F., and then transferred to a temperature of 60.8° F.*

Kept 1 day at 76.8° F	9(X)3(3)cn $\overset{\pm}{}$ / 13
" 2 " "	9(X)3(3)cn $\overset{\pm}{}$ / 12
" 3 " "	3(X)10(4)cn $\overset{-}{}$ / 14
" 4 " "	2(X)9(4)cn $\overset{-}{}$ / 11
" 5 " "	1(X)+12(4)c / 13
" 6 " "	13(4)c $\overset{\pm}{}$ / 12
" 7 " "	12(4) $\pm$ / 12
Kept continuously at 76.8° F	10(4)+ / 10
Kept continuously at 60.8° F	10(X) 2(4)c $\overset{=}{}$ / 12

rust, Joanette Strain was resistant to forms 1, 3, and 4; but kept at 76.8°F., for the same period it was susceptibile or heterogeneous in its reaction. It gave the normal heterogeneous reaction to form 5 when kept at a temperature of 60.8°F., but it was susceptible to form 5 at 76.8°F.

Conclusions

These results at least partly explain why the reaction of Joanette Strain to physiologic forms, 1, 3, 4, and 5, fluctuated at certain times in the past. The variations in temperature which occur under ordinary greenhouse conditions had undoubtedly affected the reaction of this host. Certain recent observations suggest that light is also a factor in influencing the reaction of Joanette Strain to these forms, but the relation of different intensities of light to host reactions has yet to be definitely determined.

Summary

No significant deviations from the normal reactions of the differential hosts, White Russian, Richland, and Victory, to physiologic forms of *Puccinia graminis avenae* occurred at temperatures of 57.4°, 64.8°, 71.9°, and 75.4°F.

The effect of temperature on the reactions of all the differential hosts to physiologic forms 2, 6, 7, and 8, under the conditions of this study, was negligible.

Joanette Strain showed a striking difference in its reactions to forms 1, 3, 4, and 5, at a low (57.4°F.) and at a high (75.4°F.) temperature.

Temperature fluctuations seem to account satisfactorily for variations previously observed in the reaction of Joanette Strain to forms 1, 3, 4, and 5.

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EFFECT OF TEMPERATURE ON HOST REACTIONS TO PHYSIOLOGIC FORMS OF *PUCCINIA CORONATA AVENAE* *

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Introduction

Numerous investigators have studied the effect of temperature on the development of cereal rusts, but comparatively little experimental work has been done to ascertain the effect of this factor on the responses of differential varieties to individual physiologic forms of cereal rusts. Peltier (*4*), studied the effect of temperature on the development of two physiologic forms of *Puccinia graminis tritici* (Pers.) Erikss. and Henn. He found that the rate of rust development was greatly influenced by temperature, but the type of rust infection produced on the standard differential hosts by the two biologic forms which he used was not affected by temperature. Waterhouse (*6*), observed that Joanette, although giving identical rust reactions to several physiologic forms of oat rust both in winter and summer, was susceptible to form 1 in summer but resistant to it in winter.

The effect of temperature on the development and formation of teliospores in rusts has been studied quite extensively. However, there has been considerable disagreement in the results obtained and in the conclusions drawn by different investigators. Iwanoff (*1*) studied the effect of temperature on the development of teliospores of *Puccinia violae* (Schum) D.C., and other species of rusts. He observed that teliospores formed earlier in the life of the fungus at an elevation of 2,700 meters than at 520 meters above sea level; he considered moderately low temperatures to be conducive to early formation of telia. Waters (*7*) studied the effect of environment on the formation of telia in ten rusts and came to the conclusion that any factor or set of factors such as light, moisture, and temperature, by influencing the metabolism of the host, may be responsible for the fungus changing from the urediniospore to the teliospore forming habit. Johnson (*2*), made observations on the formation of telia by ten physiologic forms of *Puccinia graminis tritici* at two different temperatures, namely, 55° to 60°F., and 70° to 75°F. He found that formation of telia occurred earlier and was more rapid at the higher temperature.

In the process of identifying physiologic forms of *Puccinia coronata avenae* (Corda) Erikss. and Henn., it was observed by the writer that the reactions of some of the cultures varied from time to time on some of the differential hosts. At first it was thought that the forms had not been completely purified or that the cultures had become contaminated, so that in the cultures two or more forms might be present, the proportions of which might vary from transfer to transfer and thus produce varying rust reactions. Later, when cultures of single spore origin were

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observed to produce fluctuating rust reactions on certain of the differential host varieties, it became quite evident that the relationship of host and fungus was being influenced by some environmental factor or factors.

Since physiologic forms of this rust are identified on the basis of their parasitic behaviour on certain oat varieties, it is important to know whether or not the variations in environmental factors encountered under ordinary greenhouses conditions influence the rust reactions of the differential hosts to such an extent that the identification of a physiologic form is affected. Temperature is undoubtedly one of the most important factors influencing rust development. As this factor varies greatly under greenhouses conditions from season to season and even from day to day, experiments were conducted to ascertain to what extent temperature influences the rust reactions of the differential host varieties to physiologic forms of crown rust of oats. The influence of this factor on telial development was also studied. During the course of these experiments, other environmental factors were kept as uniform as possible.

Experimental

Experiment 1.—Influence of temperature on rust development and formation of telia, of four physiologic forms on the six differential oat varieties.

Physiologic forms 1, 3, 4, and 7, of crown rust of oats were cultured at 57°, 70°, and 77°F., on the six differential oat varieties which have been used in identifying physiologic forms of crown rust of oats, namely, Green Mountain C.I. 1892, White Tartar C.I. 551, Green Russian (Iowa 96), Red Rustproof C.I. 1039, Sterilis Selection, and Ruakura Rustproof C.I. 2025. All the cultures, with the exception of the form 1 culture were of single-spore origin. The culture of form 1 used in this test was not monosporous but originated from a single pustule.

The plants used in the experiment were grown in four-inch pots, and were kept at ordinary greenhouse temperature up to time of inoculation. Inoculations were made when the plants were in the first-leaf stage. After inoculation, the pots were placed for 48 hours in incubation chambers, which were kept in the same houses, where subsequent rust development took place. Precautions were taken to keep the cultures pure. Rust readings were taken four days after the first pustules appeared.

Form 1 developed quite normally on all the differential varieties at these three temperatures. Although the rate of rust development on plants kept at 57°F., was retarded by about two days as compared with the rate on those kept at 77°F., the final rust reactions were identical. The lower temperature retarded the development of this form, but did not seem to affect its ultimate rust reactions on any of the differential hosts. None of the temperatures had any influence on the production of telia by this form. Telia of this form have never been observed on seedling plants.

To form 3, the rust reactions of the differential varieties were not appreciably influenced by the temperature at which the varieties were kept. Each variety produced at all these temperatures a similar rust reaction. The

development of the rust, however, as in form 1, was slower at the lower temperature. The low temperature also retarded the formation of telia. At 77°F., telia began to form about twelve days after inoculation, whereas, at 57°F., telia did not begin to appear until about twenty-two days after inoculation.

To form 4*, each of the differential hosts, except Red Rustproof, reacted identically at all three temperatures. At 70° and 77°F., Red Rustproof is highly susceptible to this form; but, at 57°F., moderately resistant to it. The formation of telia, however, is definitely affected by temperature. At the two higher temperatures, telia formed quite abundantly about three weeks after inoculation, but, at the lower temperature, 57°F., telia did not form at all.

Form 7 proved to be quite sensitive to temperature changes. To this form, all the differential varieties were completely susceptible at 77°F.; at 70°F., Green Mountain, White Tartar, and Green Russian were very resistant; at 57°F., these three varieties were practically immune. The other three varieties were completely susceptible to this form at all three temperatures. However, the rate of rust development was somewhat slower at the lowest temperature, as was found for form 1. The type of rust reaction, to this form, as expressed by three of the differential hosts may vary from 4 to 0. The temperature at which the plants are kept during the period of rust development determines which type of reaction appears. In common with form 1, form 7 has never been observed to form telia on seedling plants. At neither the high nor the low temperature were telia produced.

From this experiment it seems clear that the temperature at which the infected differential hosts are kept must be taken into account when identifying physiologic forms of crown rust of oats, at least, in so far as some of the physiologic forms are concerned. Forms 1 and 3 are not sensitive to temperature fluctuations, hence reactions of differential varieties to these two forms are not affected by temperature changes which occur under ordinary greenhouse conditions. On the other hand, the reactions of some of the differential varieties to form 4 and 7 are affected by temperature. The reaction of form 4 on Red Rustproof at the lowest temperature, 57°F., is different from its reaction on this variety at the two higher temperatures, 70° and 77°F. At 70° and 77°F., the reactions are identical with the reactions of this form as originally described by Popp (*5*), and, later, by Parson (*3*); whereas, at 57°F., this form would be described as a new form. A greater differenece is found in form 7. The rust reactions of three of the differential hosts to this form are affected by temperature. If cultured at 77F., it is indistinguishable from form 1; but, at 57° and 70°F., its reactions are characteristic of form 7. The rust reaction of each of the six differential varieties of oats used in identifying physiologic forms of crown rust of oats, to physiologic forms 7 and 4, at three different temperatures, is given in Table 1.

*Physiologic form 4 was first reported by Popp. Later Parson described and allotted numbers to forms 1, 3 and 4. Form 7 has not been reported before.

TABLE 1.—*The rust reactions of the six differential varieties of oats to physiologic forms 4 and 7 at 57°, 70° and 77° F*

Physiologic form	Temperatures	Rust Reactions					
		Green Mountain	White Tartar	Green Russian	Red Rustproof	Sterilis Sel'n	Ruakura
Form 4	57° F	4	4	4	1 - 2	4	;
	70° F	4	4	4	4	4	;
	77° F	4	4	4	4	4	;
Form 7	57° F	;	;	;	4	4	4
	70° F	; - 1 ±	; - 1 ±	; - 1 ±	4	4	4
	77° F	4	4	4	4	4	4

Experiment 2.—The effect on the rust reactions of two varieties of oats to physiologic form 7, produced by altering the temperature at different stages during incubation.

In the preceding experiment the varieties Green Mountain and White Tartar were shown to be resistant to form 7 at 57°F., and susceptible to it at 77°F. The purpose of experiment 2 was to ascertain whether or not these two varieties would acquire resistance to this form by being kept during part of the incubation period at 57°F.

Five pots of Green Mountain and White Tartar each containing ten seedling plants were inoculated with physiologic form 7 and placed in incubation chambers in the section of the greenhouse kept at 57°F. After 48 hours, the usual period allowed for infection to take place, the pots were placed on a bench in one of the sections of the greenhouse. Each day thereafter one pot of each variety was transferred to the warm section of the greenhouse kept at 77°F., until all the pots had been transferred. Similarly, duplicate sets were inoculated in the warm section kept at 77°F., and one pot was transferred each day to the section of the greenhouse kept at 57°F.

As already pointed out in the preceding experiment, the lower temperature delayed somewhat the rust development. Notes on the rust reactions, therefore, were taken four days after the first pustules appeared. The plants which were kept in the cooler section during the earlier stages of rust development and then were transferred to the warmer section became heavily infected, whereas those which were kept in the warmer section during the initial stages of rust development and later were transferred to the cooler section until rust development was complete, showed degrees of resistance which varied from practical immunity to moderate susceptibility. The degree of resistance was inversely proportional to the length of time the cultures had been kept in the warm section. For example, plants which were moved to the cool section after being two days in the warm section were more resistant than those which were allowed to remain in the warm section for three days or more before they were transferred to the cool section. This experiment was repeated with identical results.

The results of this experiment are given in Tables 2 and 3.

TABLE 2.—*The rust reactions of Green Mountain and White Tartar to form 7, when the inoculated plants were transferred to a temperature of 57° F., after being kept at a temperature of 77° F. for different lengths of time.*

No. of days kept at 77° F.	Rust reactions	
	Green Mountain	White Tartar
2	; - cn	;
3	; to 1 - cn	; to 1 ± - cn
4	1 ± - cn	1 ± - cn
5	1 to 2 - cn	1 to 2 - cn
6	1 to 3 - cn	1 to 3 - cn

TABLE 3.—*The rust reactions of Green Mountain and White Tartar to form 7, when the inoculated plants were transferred to a temperature of 77° F., after being kept at a temperature of 57° F. for different lengths of time.*

No. of days kept at 57° F.	Rust reactions	
	Green Mountain	White Tartar
2	4	4
3	4	4
4	4	4
5	4	4
6	4	4

As is shown in Table 3, these varieties became heavily infected when transferred from the lower to the higher temperature. Hence the resistance which they showed at the lower temperature was only temporary in nature and disappeared soon after the plants were transferred to the higher temperature.

Since Green Mountain and White Tartar are susceptible to physiologic form 7 at 77°F., the inability of this form to develop on these two varieties at 57°F., must be due, either to the failure of this form to develop normally at this temperature, or to some change which takes place in the host itself. The fact, however, that physiologic form 7 produces heavy infection on Victory, Red Rustproof, Sterilis Selection, and Ruakura Rustproof at 57°F., indicates that at this temperature the vigor of form 7 has not diminished. On the other hand, the extreme susceptibility of Green Mountain and White Tartar to forms 1, 3, and 4, at 57°F., seems to indicate that these varieties have not undergone any great change. It is quite possible that at the lower temperature some substance may be formed in the host, which is quite harmless to forms 1, 3, and 4, but toxic to form 7.

Experiment 3.—The effect of alternating temperatures during incubation period on the rust reactions of three oat varieties.

Greenhouse temperatures, as a rule, are subject to considerable daily fluctuations. Generally the temperature during the day is considerably higher than the temperature during the night. Experiment No. 3 was carried out to ascertain whether or not similar daily fluctuations in temperature would affect rust reactions.

Seedling plants of Victory, Green Mountain, and White Tartar, which were growing in the section of the greenhouse kept at 77°F., were inoculated with form 7. Three pots of each variety were inoculated and, after 48 hours in the incubation chamber they were placed on the greenhouse bench. Each pot contained ten plants. One pot of each variety was kept at 77°F. as a control, while two pots of each variety were kept at that temperature during the day, but in the evening were transferred for a twelve-hour period to a section of the greenhouse kept at a temperature of 57°F. At the end of the incubation period, the plants of each variety kept constantly at the higher temperature were all heavily rusted. This similarity of reaction did not occur in those plants that were subjected alternately to the higher and lower temperatures. Victory was completely susceptible, whereas, the plants of the other two varieties were highly resistant. On these latter plants numerous flecks appeared, but rarely did pustules form. When pustules did form, they were always minute and widely scattered. A second trial gave identical results.

It seems evident, therefore, that regular daily fluctuations in temperature during the incubation period influence very markedly the rust reactions of Green Mountain and White Tartar to form 7. Hence it may be concluded that daily fluctuations in greenhouse temperature, if of equivalent magnitude and duration to those in this experiment, would alter the rust reactions of this form on the varieties, Green Mountain and White Tartar, but not on Victory. The minimum degree of daily temperature fluctuation capable of noticeably affecting the development of form 7 on these two varieties has not been determined.

Temperature fluctuations which exceed in magnitude the temperature fluctuations which obtained in the foregoing experiment occur in the greenhouses at Winnipeg, Man., particularly during the summer months. This is shown by the thermograph charts. For instance, the average temperature during the month of January, 1929, was 57°F., while that during the month of July of the same year was 75°F. On some days in January the temperature was considerably lower, and on some days in July the temperature was considerably higher than the averages indicated. Even on the same day, during the summer, there is frequently a spread of 25°F., between minimum and maximum temperature.

These results emphasize the importance of maintaining a uniform greenhouse temperature while the identification of physiologic forms of *Puccinia coronata avenae* is in progress. Unless a uniform temperature is maintained, some of the physiologic forms of this rust will show considerable variation in rust reaction on several of the differential varieties. While the identification of the physiologic forms is being carried on the temperature of the greenhouse should be kept as uniform as possible. Possibly the most suitable temperature is 70°F. In recording the reactions of physiologic forms of crown rust of oats, investigators should state at what temperature the differential hosts were kept during the period of rust development.

SUMMARY

1. The effect of temperature on the development of physiologic forms 1, 3, 4, and 7, of crown rust of oats on six differential host varieties of oats was studied, as was also the influence of this factor on the formation of telia in these four physiologic forms.
2. Cultures of each of these forms were incubated at the three following temperatures, 57°, 70°, and 77°F.
3. The rate of rust development on the plants inoculated with these forms kept at 57°F., was retarded by about two days, as compared with the rate of development on those kept at 77°F.
4. The type of rust reaction produced by forms 1 and 3 was not influenced by temperature.
5. One variety, Red Rustproof, was susceptible to form 4 at 70° and 77°F., but resistant to it at 57°F.
6. Form 7 developed heavily on all the differential varieties at 77°F., but at 57°F., it failed to produce spores on Green Mountain, White Tartar, and Green Russian.
7. Seedling plants of Green Mountain and White Tartar which were infected with form 7 and kept at 77°F. for four days or less, and then transferred to a temperature of 57°F. for subsequent rust development, proved resistant.
8. Seedling plants of Green Mountain and White Tartar which were infected with form 7 and kept at a temperature of 57°F. for four days or less following infection, and then transferred to a temperature of 77°F. for subsequent rust development, rusted heavily.
9. Seedling plants of Green Mountain and White Tartar infected with form 7 and kept at a temperature of 77°F. during the day, and at 57°F. for a twelve hour period each night during the period of rust development, were highly resistant.

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STABILISATION DE LA MAIN-D'OEUVRE ET ORGANISATION GENERALE DE L'EXPLOITATION DE VAULUISANT (YONNE)

MM. Adolphe Javal et Jacques Faugeras *

Dieuxieme Partie

Nous allons grouper dans ce chapitre d'organisation générale les éléments suivants :

1. La répartition des fonctions fayoliennes ;
2. Les fiches de fonctions techniques ;
3. Les moteurs artificiels ;
4. Les systèmes.

1. *La répartition des fonctions fayoliennes.*

Parmi les six fonctions fayoliennes, seule la fonction technique comporte du personnel subordonné ; toutes les autres sont remplies soit par le chef, soit par le contremaître.

Les Fonctions

Fonction Technique—Elle est divisée très nettement en deux sections ; les travaux à l'intérieur de la cour de ferme, dirigés par le chef ; les travaux des champs, dirigés par le régisseur. Toutefois le chef n'intervient pas dans les ordres donnés par le régisseur. Si les comptes rendus de celui-ci ne correspondent pas aux prévisions antérieurement établies, le chef va sur place exercer son contrôle et donner des ordres pour que les prévisions soient modifiées ou réalisées.

Réciproquement, le régisseur n'intervient pas dans les ordres donnés par le chef, sauf en case de mission spéciale. Cette entente permet l'unité de direction et d'autorité.

Fonction Commerciale—Le chef achète et vend le grain, les betteraves, le matériel ; il achète le travail, c'est-à-dire fixe les salaires.

Le régisseur achète et vend le bétail, après avoir demandé l'accord du chef pour l'obtention des crédits, s'il y a lieu.

Fonction Financière—Remplie par le chef. Il ressort des calculs effectués qu'une production moyenne en grains de 20 quintaux à l'hectare attribue approximativement un intérêt de 3 p. 100 aux capitaux représentés : a) par la terre et les bâtiments ; b) par les biens mobiliers : cheptel vif et mort. Au-dessus de cette production de 20 quintaux commence le bénéfice net, compte tenu de l'entretien en bon père de famille de ces biens immobiliers et mobiliers.

Fonction comptable—Le chef tient : un livre de caisse ; un livre de salaires ; un livre de situation mensuelle ; un livre d'inventaire ; un dossier fournisseurs, bons de livraison clients et avis de chemins de fer.

Fonction de Sécurité.—Les accidents et l'incendie sont couverts par l'assurance. La sauvegarde des récoltes, du bétail et des outils de travail doit

Etude présentée par M M. Adolphe Javal, docteur és sciences, et Jacques Faugeras, ingénieur agronome, au 4° Congrès international de l'Organisation scientifique du Travail, Paris, 1929.

*M. Faugeras est, à l'heure actuelle en voyage d'études au Canada et aux Etats-Unis ; il lui a été accordé une bourse d'études de la fondation Rockefeller.

être assurée, en cas de mauvais temps persistant ou d'accident quelconque par les ouvriers, conformément à une dérogation stipulée au règlement de travail.

Fonction Administrative.—Elle est presque exclusivement entre les mains du chef d'exploitation, qui a amené l'état actuel de l'organisation et fixé le règlement de travail. Cette fonction se présente comme suit:

a) Prévoyance:
Des programmes d'action:
Assolements;
Productions à venir évaluées approximativement d'après l'amélioration des façons culturales et l'imploi croissant des engrais);
Des multations de personnel:
Par l'aspect des jardins;
Par la sélection des ouvriers selon leurs capacités;
Des tâches de remplacement:
En cas d'intempéries ou d'accidents empêchant des travaux d'être exécutés;
Des oeuvres sociales:
Entretien des maisons et jardins;
Achat de denrées des première nécessité;
Distractions (T.S.F. et cinéma); et autres
Hygiène (W.-C., douches).

b) Organisation:
Recrutement du personnel et fixation des tâches;
Fixation du règlement de travail;
Modifications dans l'emploi du matériel.

c) Coördination.—Les attributions du chef et du contremaître sont partagées comme nous l'avons vu plus haut aux tonctions. D'ailleurs le chef et le régisseur sont sans cesse en contact. Les attributions des ouvriers ont été signalées plus haut, au tableau d'organisation et au paragraphe "Augmentation du nombre des façons culturales". Les suppléances sont assurées pour les dirigeants comme pour les ouvriers.

d) Commandement.—Le chef commande les travaux dans la cour de la ferme; les régisseur ceux des champs.

e) Contôle.—Il est effectué par chaque chef, chacun dans son ressort. Toutefois, le régisseur contrôle l'arrivée et le départ de tous les ouvriers: par individu et par heure.

Par ailleurs, grâce à la disposition surélevée des pièces de terre tout autour de la ferme, il est possible d'apercevoir de celle-ci les hommes et les machines au travail dans les champs.

2. *Fiches de fonctions techniques.*

Dans certaines industries, on indique depuis quelque temps par écrit à chaque ouvrier les points essentiels, les responsabilités de son travail et la place qu'il occupe dans la chaîne des opérations de fabrications. Le document ainsi dressé est la fiche de fonction.

Nous n'en sommes pas encore là dans les exploitations agricoles. D'abord parce que chaque fonction nécessite des connaissances pratiques très vastes, même pour le spécialiste: vacher, mécanicien, maçon, berger. Et aussi parce que chaque fonction met l'ouvrier en présence de problèmes, de décisions à prendre qui sont différentes tous les jours, même plusieurs fois par jour; parce que le même geste, la même situation, se renouvellent rarement ou à de longs mois d'intervalle. Certes, il est des mouvements, il est des précautions qui ne changent pas pour certains travaux agricoles, et que l'on pourrait noter sur le papier.

Mais il y a une autre difficulté, d'ordre psychologique: il est à craindre que les ouvriers, après avoir pris connaissance de leur fiches respectives—ou même sans les avoir lues—les jettent directement au fumier. Déjà il est extrêmement malaisé d'obtenir d'eux de l'ordre dans l'utilisation rationnelle et le rangement des outils à main; fourches, échelles, etc. Il est très probable que la mise en service de fiches de fonction, sans une éducation préalable de l'état d'esprit du personnel, court à un échec assuré.

3. *Les Moteurs Artificiels.*

Il y a à Vauluisant 12 moteurs électriques et 2 tracteurs Austin, plus un moteur à vent pour l'élévation de l'eau. Les premiers sont tous fixes, sauf celui du grenier, qui est sur brouette pour pouvoir s'approcher des tas. Mais il y en a deux qui sont comptés comme fixes parce que l'on ne les déplace qu'une fois par an sur des positions repérées: celui de la batteuse (l'hiver au battage et l'été au silo) et celui du tarare de cour, qui sert à l'affûtage des lames de faucheuses quand le battage est fini. Tous travaillent dans un but déterminé.

Nature du travail effectué	Puissance	Heures de Travail (ou jours) par année.
Battage	7 CV	100 jours à 6 heures
Ensilage		6 jours à 10 heures
Ecrémage, barrattage et malaxage	9/10 CV	180 heures
Découpage des betteraves et decrottage	2, 5 CV	187 heures
Sciage des bûches et charronnage	2, CV	155 heures
Tarare et affûtage des scies	1 CV	53 jours de 10 heures
Aplatissage et concassage des graines	2 CV	500 heures
Triage des semences et tarares du grenier	1 CV	13 jours de 10 heures
Elévation de paille et foin	2, 5 CV	25 jours
Quatre moteurs: au lavoir, à la tonte des moutons, à la pompe à purin (en cours d'installation)		Non évalués
Totaux	19 CV	env. 2.600 heures

Les tracteurs Austin ne servent jamais comme moteurs fixes. Ils ont une puissance de 25 CV. Ce sont surtout des appareils de secours pour des époques où les chevaux sont insuffisants. Ils travaillent chacun 30 jours par an:

12 jours de pulvérisation en avril;

11-12 jours de moisson du 15 juillet au 15 août;

6 jours de déchaumage du 15 août au 15 septembre.

4. *Les systèmes.*

On connaît la définition donnée de ce terme: "Un moyen qui, par des dispositifs matériels bien adaptés, simples et complets, assure l'exécution d'une tâche déterminée, d'un travail quelconque, avec le minimum de perte de temps, avec le minimum d'efforts, avec le maximum d'efficacité."

Dans un autre rapport, intitulé "Analyse des opérations d'une culture de blé sur betterave" (1), l'un de nous a analysé les opérations effectuées par les systèmes nécessaires à cette culture.

Voici quelques systèmes utilisés dans l'exploitation de Vauluisant. (On trouvera un peu plus bas l'analyse de l'utilisation du système silo.)

Systèmes	Nombre approximatif des jours de travail par an
Moissonneuse Massey-Harris	8
Rouleau de 600 kilos (3 billes)	12
Semoir à engrais "Chantejot"	23-25
Elévateur de paille et de foin	25
Herse à trois trains	40
Chariot à fourrage	52
Batteuse "Vendeuvre"	100 (60 si elle fonctionnait au maximum de sa capacité)
Brabant "Bajac" un soc	100
Silo en maçonnerie	180
Machine à écrire (correspondance avec les administrations publiques)	304

(1) Presente a ce Meme Congres par M. Faugeras

Un Exemple: Le Systeme Silo

Ce système a été installé pour réaliser les avantages suivants:

Soustraire aux conditions atmosphériques le fourrage légumineux coupe et sur pré;

Eviter les perturbations dans les divers travaux provoquées par un retard dans le fanage et le séchage sur le pré;

Accélérer la rentrée du fourrage;

Augmenter la production par tête d'ouvrier occupé aux opérations effectuées entre la fauchaison et la mise en grange.

Organisation de la Production—Le silo a été établi pour contenir la nourriture de 30 vaches pendant 180 jours, soit, à raison de 20 kilos par tête, 600 kilos par jour et 108 tonnes pour six mois, correspondant à 5 hectares de prairie à légumineuses environ et correspondant à un cylindre de 10 mètres de hauteur et 4 m. 50 de diamètre intérieur et à un minimum de 5 centimètres d'épaisseur de fourrage consommé par jour.

Le blizzard, qui sert à ensiler, a un débit maximum de 6 tonnes à l'heure, soit un chariot d'une tonne toutes les dix minutes, ce qui est environ deux fois supérieur aux possibilités pratiques, qui sont les suivantes:

Organisation du Travail.—Il s'agit d'amener "le plus vite possible" 110 tonnes de fourrage vert du pré dans le silo. Ce "plus vite possible" en fait est déterminé par le blizzard et s'élève 5 jours, soit 1 hectare, ou 21 à 22 tonnes par journée de dix heures et demie, en évitant que du fourrage reste sur le pré, fauché, le soir:

Voici le plan d'organisation appliqué:

1. Fauchaison.—Moyenne de 1 hectare par jour: 1 conducteur, 2 chevaux, 1 faucheuse. En fait, la faucheuse travaille environ quatre heures par jour pour donner ce régime de production.

2. Chargement sur le pré.—30 chariots par journée: 1 manoeuvre fixe, 2 charretiers, 2 chariots, 3 à 4 chevaux. Durée du chargement d'un chariot: vingt minutes.

3. Transport.—1 chariot avec 1 charretier et 2 chevaux. Durée: 5 minutes à une demi-heure, selon la distance de la pièce.

4. Déchargement et ensilage.—30 chariots par journée, soit un chariot de 750 kilos toutes les vingt minutes: 2 manoeuvres fixes, 1 charretier, 1 chariot, 1 ou 2 chevaux. Durée du déchargement d'un chariot: vingt minutes.

Totaux des quatre chantiers: 1 conducteur de faucheuse, 3 charretiers, 3 manoeuvres, soit 7 ouvriers; 9 chevaux, 4 chariots, 1 faucheuse.

Le système, de la fauchaison à l'ensilage, exige donc un ouvrier pour une production totale de

$$\frac{100}{7}, \text{ soit } 15,\ 7 \text{ toones, soit} \frac{100}{7 \times 5} \text{ 2,050 tonnes par}$$

ouvrier et par jour. Aucun système, à notre connaissance, n'a pu encore élever la production de la main-d'oeuvre à un chiffre aussi élevé pour la coupe, la rentrée et la conservation du fourrage.

Resume

L'exploitation agricole de Vauluisant est caractérisée principalement par la fixité absolue du nombre des ouvriers, 30, et du nombre des heures de travail, 3,040 par homme et par an. Sur les 72,000 heures réellement fournis par an, la moitié correspond à des travaux hors la cour de ferme, l'autre moitié à des travaux dans la cour. Ces derniers sont menés beaucoup plus rapidement—à cause des distances réduites—et peuvent être plus aisément contrôlés que les premiers.

L'attribution de séries de tâches déterminées à différents spécialistes a amené la part des salaires à un taux assez élevé: environ 50 p. 100 des dépenses totales de l'exploitation.

Grâce à l'utilisation de divers systèmes, qui exécutent rapidement les tâches pressées et permettent d'allonger les périodes d'exécution des tâches non pressées, la stabilisation de la main1d'oeuvre a été établie. Il est possible de prévoir d'ici quelques années—si les relations avec les services publics s'améliorent—une nouvelle étape vers la journée de huit heures pour le personnel.

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NOUVELLES DE NOS MEMBRES

Nous sommes très heureux d'annoncer que Monsieur Georges Michaud, B.S.A., Agronome de Edmundston, N.B., a accepté la position de propagandiste pour l'association des Eleveurs d'Ayrshire pour la Province de Québec. La nouvelle adresse de M. Michaud est 507, rue St. Cyrille, Québec. Ce distingué technicien agricole entrera en devoir le ou vers le 1er octobre. Nos meilleurs voeux de succès à M. Michaud dans ses nouvelles fonctions.

Le Ministère de l'Agriculture de Québec vient de s'adjoindre les services d'une boursier de l'Université de Cornell dans la personne de M. Henri L. Bérard, qui est entré en fonctions ces jours derniers, au Service de l'Industrie Animale.

M. Bérard est né à St-Marcel, comté de Richelieu. En 1922, il entra à l'Institut Agricole d'Oka, dont il sortit en 1926 avec le diplôme de B.S.A. Il fit ensuite un stage de six mois à l'Ecole de Laiterie de St-Hyacinthe où il étudia spécialement les divers procédés de la fabrication du beurre. Après avoir obtenu à cet endroit le diplôme d'expert-essayeur de lait, il alla faire un autre stage de cinq mois, en 1927, dans une fabrique de fromage, à Chambord, Lac St-Jean.

Enfin, au mois de septembre 1927, le Ministère de l'Agriculture de Québec lui accordait une bourse pour lui permettre d'aller poursuivre des études plus avancées a l'Université de Cornell, Ithaca, N. Y. M. Bérard demeura dans cette institution jusqu'au mois de juin 1930, alors qu'il en revint avec le titre de Docteur-ès-sciences. Le principal sujet des études du boursier à Cornell fut la bactériologie du lait, et les sujets secondaires portèrent sur la biochimie et la fabrication des produits laitiers, beurre, fromage, crème à la glace, lait condensé, lait en poudre, ets.

Au Ministère de l'Agriculture, le travail de M. Bérard consistera principalement dans l'organisation des fabriques de beurre et de fromage d'après les méthodes les plus économiques, et dans le groupement aussi des producteurs de lait en vue de la vente de leur produit en nature dans les grands centres.

CONCERNING THE C.S.T.A.

Notes and News

W. J. Strong (Toronto '21), who holds the position of Hybridist in Small Fruits and Vegetables at the Vineland Experimental Station, has been awarded the degree of M.S.A. by the University of Toronto. We hope to publish shortly an abstract of his thesis, "Studies on the Genetics of the Cucumber."

E. E. Eisenhauer (Saskatchewan '18), who is with the Alberta Wheat Pool has changed his address to 1016-14th Ave. W., Calgary, Alta.

K. W. Neatby (Saskatchewan '24), Cereal Specialist at the Dominion Rust Research Laboratory, Winnipeg, is continuing his graduate studies at the University of Minnesota and may be reached in care of the Division of Agronomy and Plant Genetics, University Farm, St. Paul, Minn.

C. W. Leggatt (Toronto '21), has been appointed Supervising Analyst of District No. 4 under the Seed Branch, Dominion Department of Agriculture, with headquarters at Toronto. His home address will be 84 Collier St., Toronto 5, Ont.

Benjamin Bourgault (Laval '17), is now Manager of the Department of Seed, Feed, Fertilizers, and Binder Twine for the Coopérative Fédérée de Quebec at 130 St. Paul East, Montreal.

Armand Gelinas (Montreal '20) has accepted the position of Agronome Propagondiste with the Coopérative Fédérée de Quebec, 38-40 Marché Champlain, Quebec.

Victor E. Graham (Saskatchewan '27) was married on August 12th to Miss Grace Carleton of Three Forks, Montana. Mr. Graham will commence his duties this fall as Assistant Professor of Dairying at the University of Saskatchewan, Saskatoon.

Dr. W. P. Thompson (Toronto '10), Professor of Biology, University of Saskatchewan, returned recently after a year's absence spent chiefly at Berkely, California.

Prof. E. H. Edmunds of the Geology and Minerology Department, University of Saskatchewan, was one of those in attendance at the "North of 53" sessions of the Mining Institute, recently held in the mineral belt of Northern Manitoba.

M. A. Collins (Saskatchewan '28) and W. G. Kirk (Saskatchewan '28), instructors in Dairying and Animal Husbandry respectively, have left for Ames, Iowa, to take graduate work.

W. B. George (Toronto '23), Lecturer in Chemistry, Soils and Apiculture at the Kemptville Agricultural School, Kemptville, Ont., was married on September 6th to Miss Ellen E. Weaver of Mountain, Ont.

B. G. Montserin (McGill '27) has been recently appointed Agricultural Officer at Trinidad, B.W.I., where his address will be Santa Margarita, St. Joseph, Trinidad, B.W.I. Mr. Montserin's new position in the British Colonial Service at this point will take him back to the land of his birth.

J. G. Morgan, Poultry Assistant, Dominion Experimental Farms Branch, recently returned from the World's Poultry Congress, London, England, where he assisted in caring for the Canadian exhibit of poultry.

Leslie Wood (Toronto '21), Poultry Superintendent, New Brunswick, attended the World's Poultry Congress following which he took the tour of the British Isles arranged for delegates to the Congress. Mrs. Wood accompanied him on the trip.

Georges E. Michaud, (Laval '09) has left the District Agricultural Representative Service of the New Brunswick Department of Agriculture and will shortly take up his duties with the Canadian Ayrshire Breeders' Association as Fieldman in the Province of Quebec.

The marriage of Stanley Wood (Toronto '23), Assistant Live Stock Superintendent, New Brunswick, to Emily B. Oulton, took place in Moncton on August 9th. Mr. and Mrs. Wood are residing at 263 Saunders St., Fredericton.

New Members

During the month of August the following were duly elected to membership in the C.S.T.A.

Miss E. M. Ewens holds the position of Seed Analyst in the Dominion Seed Laboratory at Saskatoon. She graduated from the University of Manitoba in 1924 with the degree of B.H.Ec.

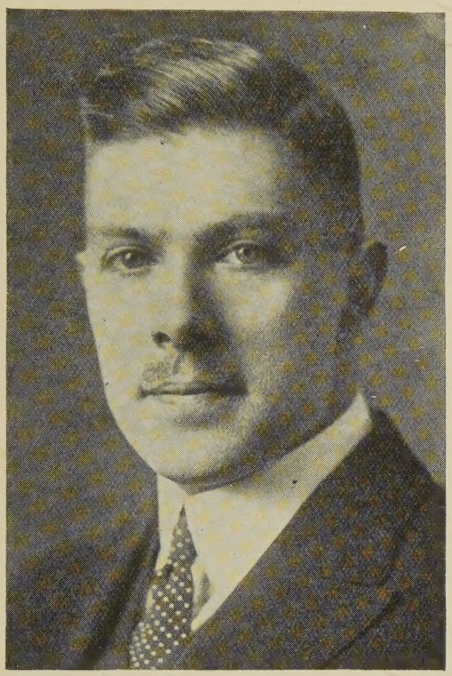
Howard W. Mead is Assistant Plant Pathologist at the Dominion Laboratory of Plant Pathology at Saskatoon. He obtained his B.Sc. from the University of Saskatchewan in 1926 and his M.Sc. in 1930.

Ernest C. Hope has been recently appointed to the position of Assistant Professor of Farm Management at the University of Saskatchewan. Previous to this time he was lecturer in Farm Economics at the Ontario Agricultural College. He graduated from the University of British Columbia in 1924 and received his M.S. at Cornell in 1928. Professor Hope's article on "Live Stock Cycles in Canada" appears in this issue of "*Scientific Agriculture.*"

Frank W. Reinoehl is Chief Farm Manager of the Colonization Finance Corporation Ltd., of 460 Main St., Winnipeg. Mr. Reinoehl has a splendid record of farm management work on a large scale in the Western States. He graduated from Mt. Union College and Columbia University, N.Y., in 1917 obtaining the degrees of A.B. and A.M.

George R. Lane (Toronto '24), Wins Charles Lathrop Pack Forestry Scholarship

Making its first award of fellowships ranging up to $1,800 a year for training leaders in forestry, the Charles Lathrop Pack Forest Education Board announced its selection of five Americans and one Canadian for the year 1930. The winning candidates were chosen from about 90 contestants.



George Ritchie Lane is a graduate of the Ontario Agricultural College (B.S.A.), a graduate of the Faculty of Forestry, University of Toronto (B.Sc.F.), and is an ex-officer of the Canadian Expeditionary Force. Until 1929 he was superintendent of the provincial forest station at Midhurst, Ontario, for the Ontario Forestry Branch.

Mr. Lane is at present with the Canada Power and Paper Company at Grand Mere, Quebec. He has done considerable experimental work with fertilizers on nursery trees, increasing the growth and enabling them to stand the shock of transplanting with less loss than usual. The present planting programme under his direction calls for the reforesting of 5,000,000 trees in 1931, and 10,000,000 in each of the following two years.

President and Secretary to Visit Western Canada

Shortly after his return from England where he has been attending the International Horticultural Congress and a conference of the Imperial Bureau of Fruit Production, Dr. W. T. Macoun, President of the C.S.T.A. will proceed on a tour of Western Canada visiting the Dominion Experimental Stations. He will be joined in British Columbia by the General Secretary, H. L. Trueman, and together they will address a series of meetings at all the branches of the Society in the west. Dr. Macoun will have an interesting report of his trip to Europe and in addition will discuss C.S.T.A. matters. While all arrangements have not been completed it is expected that meetings will be held as follows:

Kelowna	October 20th
Vancouver	" 22nd
Vancouver Island	" 23rd or 24th
Calgary	" 27th

Edmonton	"	29th
Saskatoon	"	31st
Regina	November	1st
Winnipeg	"	3rd
Kapuskasing	"	5th

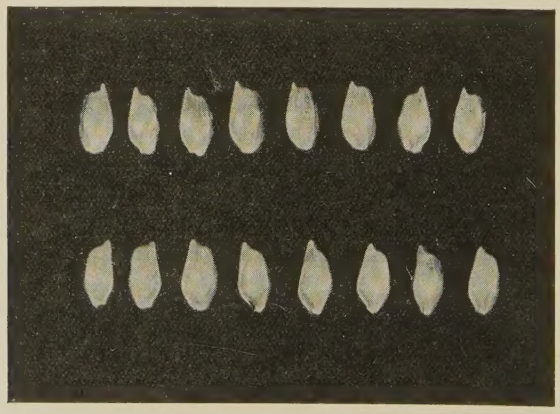
In addition to these dates Dr. Macoun may speak at Lethbridge on October 15th on his way out. He will also be at Morden, October 10th, Brandon October 11th, Indian Head October 13th, Swift Current October 14th, Colvalli October 16th, Windermere October 17th, Cranbrook October 18th, Nelson October 18th, and Summerland October 20th. The General Secretary will not accompany him on the way out but will join him in British Columbia on October 20th.

They will also visit Lacombe on October 28th and Dr. Macoun will be at Wilkie October 30th, Scott October 30th, and Rosthern October 31st.

Members should get in touch with their local secretaries in order to be sure of the exact dates and hours of these meetings. The General Secretary regrets that he cannot take the full five weeks trip with the President, but the pressure of work in the Ottawa office is too great at present to allow him to be absent more than three weeks.

Erratum in September Issue

In the September 1930 issue of *Scientific Agriculture* (Volume XI, No. 1) the cut entitled Figure 2 on page 46 is upside down. Members who are interested in the article on, "The Source and Nature of Variability in a Strain of Marquis Wheat", will please note this cut printed in correct form below. Our apologies are due Prof. J. B. Harrington for permitting this error to occur.



SELECTED LIST OF ACCESSIONS TO THE MAIN LIBRARY OF THE DEPARTMENT OF AGRICULTURE, WEST BLOCK, OTTAWA.

(Members of the C.S.T.A. may borrow books and periodicals postfree.)

Through the courtesy of Miss A. L. Shaw, Librarian of the Department of Agriculture Library at Ottawa, C.S.T.A. members receive regularly a list of accessions to the Library. During the last fiscal year there have been over six thousand loans made to C.S.T.A. members. The mailing list of accessions has grown somewhat larger than desired and it has been necessary to reduce it considerably. It will still be sent to those borrowing extensively.

During the next few months a brief accession list will be published in the advertising section of *Scientific Agriculture* each month. This permits of more rapid service than the general mailing list which is sent out every two months. Members who desire any publication on the list should address a request to Miss A. L. Shaw, Librarian, Department of Agriculture Library, Ottawa, Ont.

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